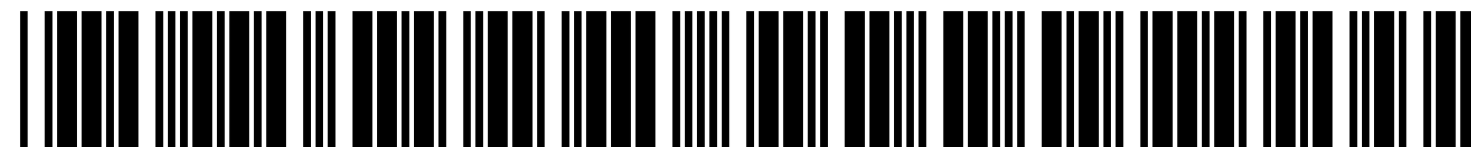

(12) **United States Patent**
Ootorii et al.

(10) **Patent No.: US 11,370,047 B2**
(45) **Date of Patent: Jun. 28, 2022**

(54) **METHOD OF MANUFACTURING MOUNTING SUBSTRATE AND METHOD OF MANUFACTURING ELECTRONIC APPARATUS**

(71) Applicant: **Sony Corporation**, Tokyo (JP)

(72) Inventors: **Hiizu Ootorii**, Kanagawa (JP); **Kiwamu Adachi**, Kanagawa (JP); **Takeshi Mizuno**, Tokyo (JP)

(73) Assignee: **Sony Semiconductor Solutions Corporation**, Kanagawa (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/270,762**

(22) Filed: **May 6, 2014**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 16, 2013 (JP) JP2013-104225

(51) **Int. Cl.**

H01L 23/00 (2006.01)
B23K 1/20 (2006.01)
H05K 13/04 (2006.01)

(52) **U.S. Cl.**

CPC ***B23K 1/20*** (2013.01); ***H01L 24/95*** (2013.01); ***H05K 13/0469*** (2013.01); *H01L 2224/16225* (2013.01); *H01L 2924/12041* (2013.01); *H01L 2924/12042* (2013.01); *H01L 2924/12043* (2013.01); *H01L 2924/15788* (2013.01)

(58) **Field of Classification Search**

CPC B23K 1/203; B23K 1/20; H05K 13/0465
USPC 228/180.22
See application file for complete search history.

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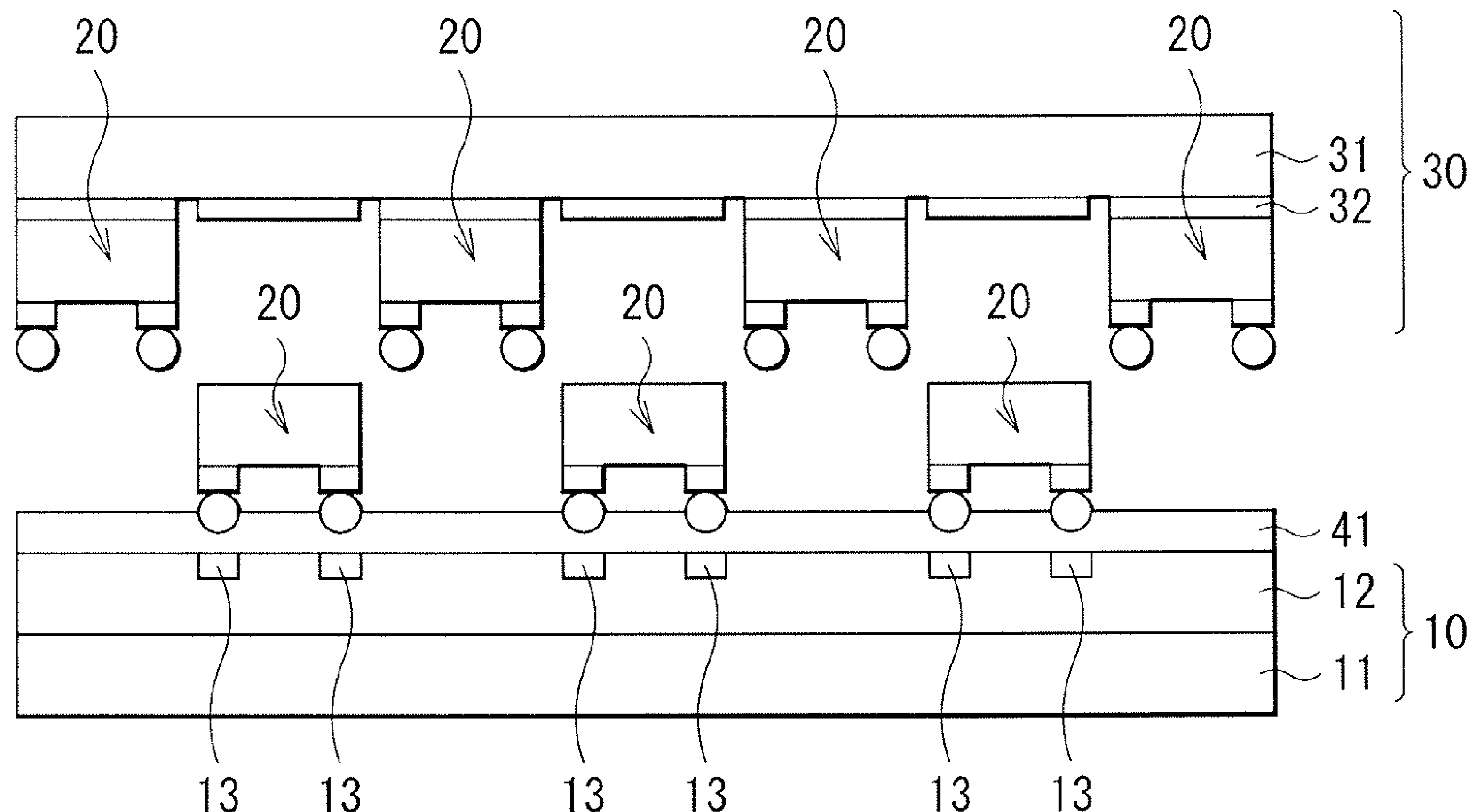
Primary Examiner — Erin B Saad
Assistant Examiner — Carlos J Gamino
(74) *Attorney, Agent, or Firm* — K&L Gates LLP

(57) **ABSTRACT**

A method of manufacturing a mounting substrate, the method includes: transferring part or all of a plurality of devices on a device substrate onto a wiring substrate, and temporarily fixing the transferred devices to the wiring substrate with use of a fixing layer having viscosity, the device substrate including a support substrate and the plurality of devices fixed on the support substrate; and performing a reflow process on the wiring substrate to electrically connect the transferred devices with the wiring substrate, and thereby forming the mounting substrate.

5 Claims, 26 Drawing Sheets



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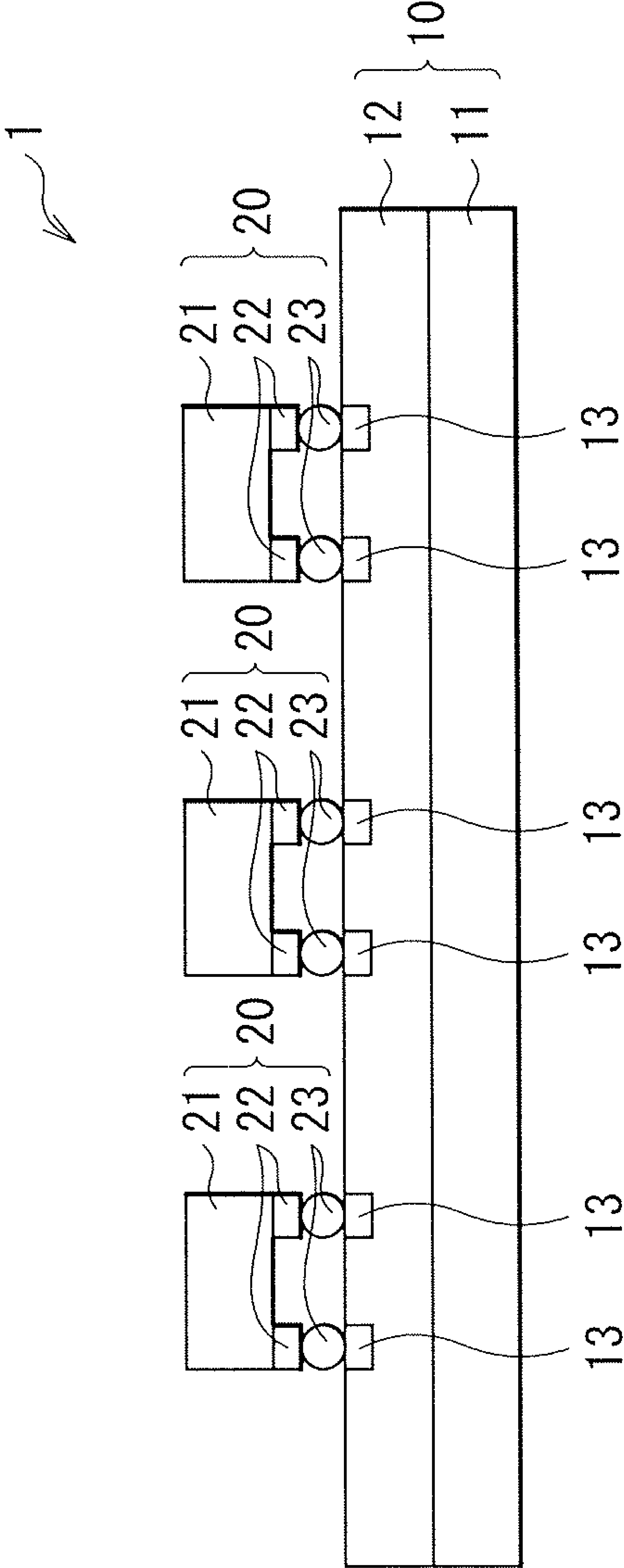


FIG. 1

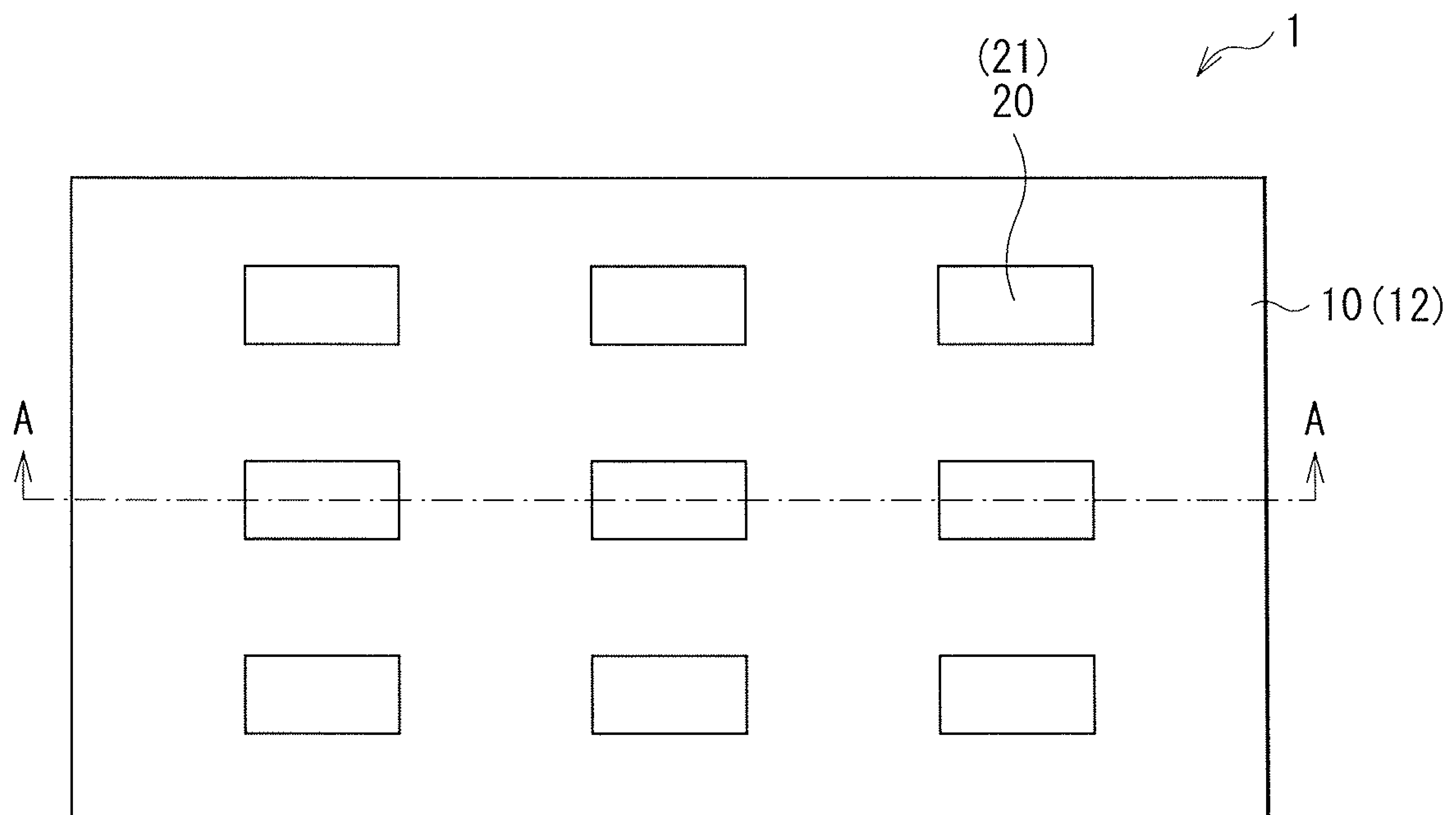


FIG. 2

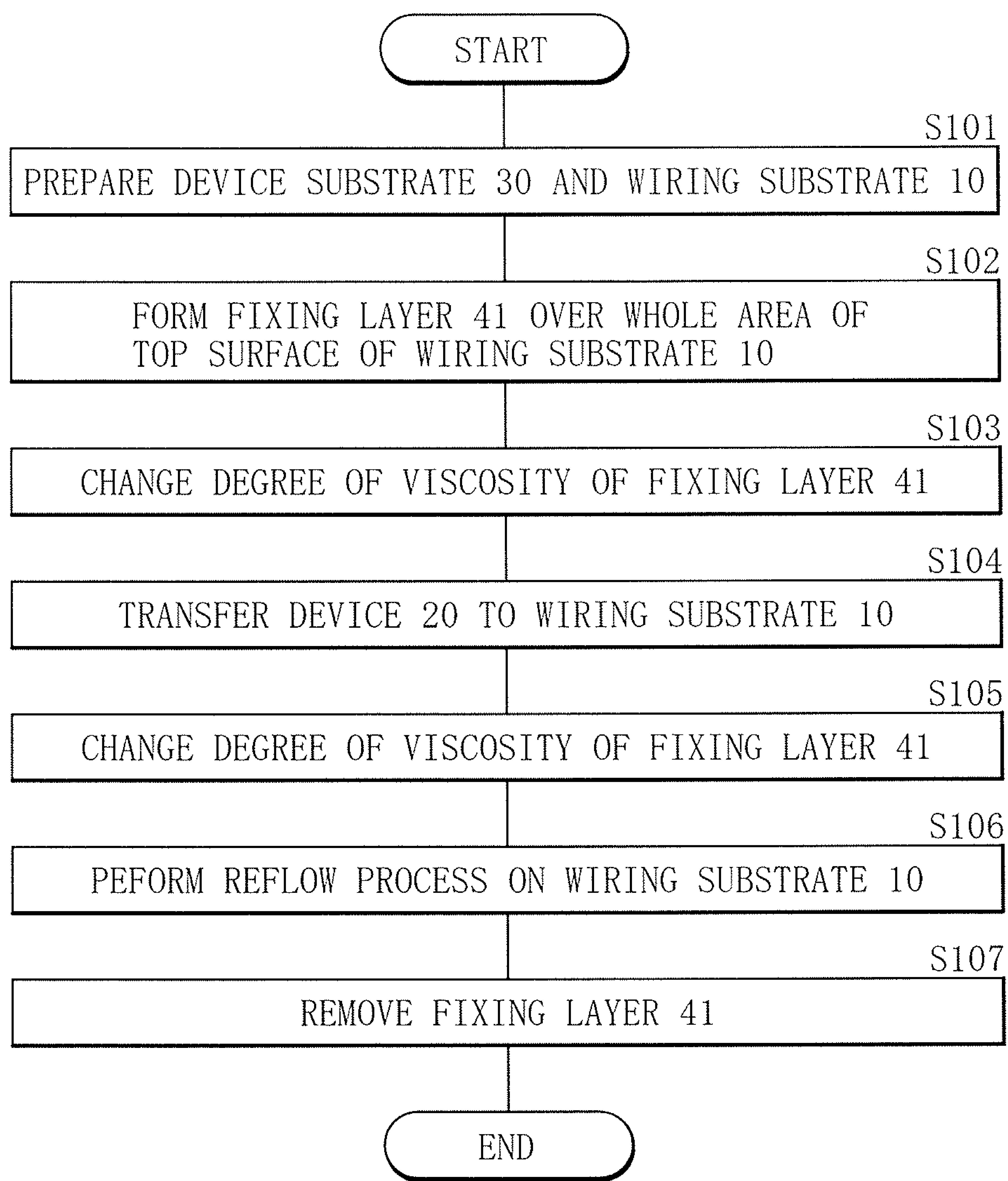
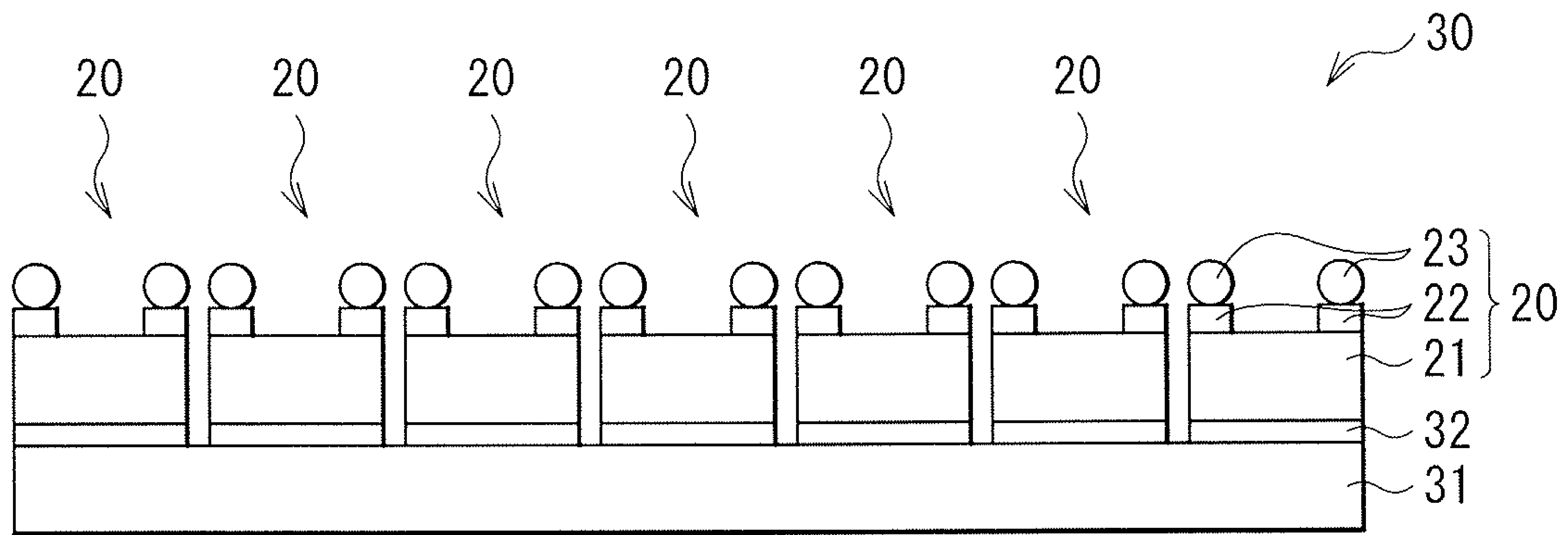


FIG. 3



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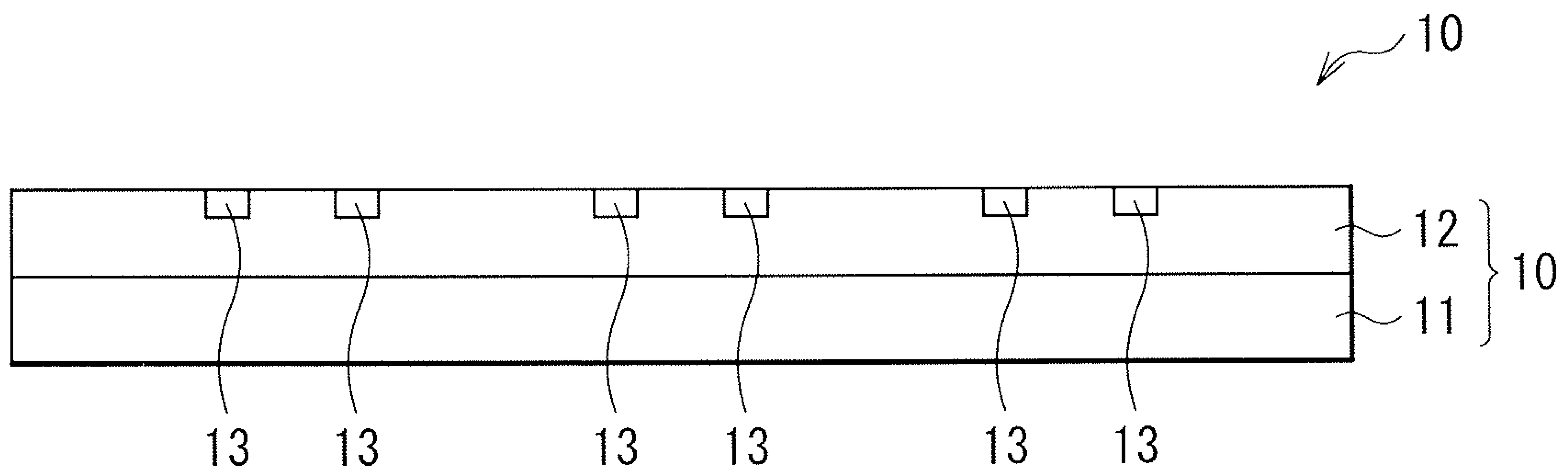

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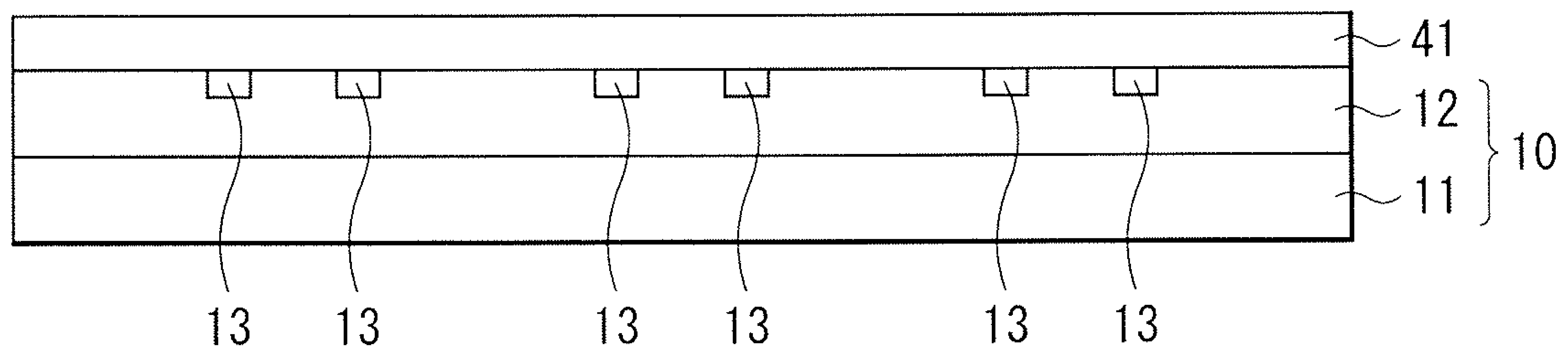

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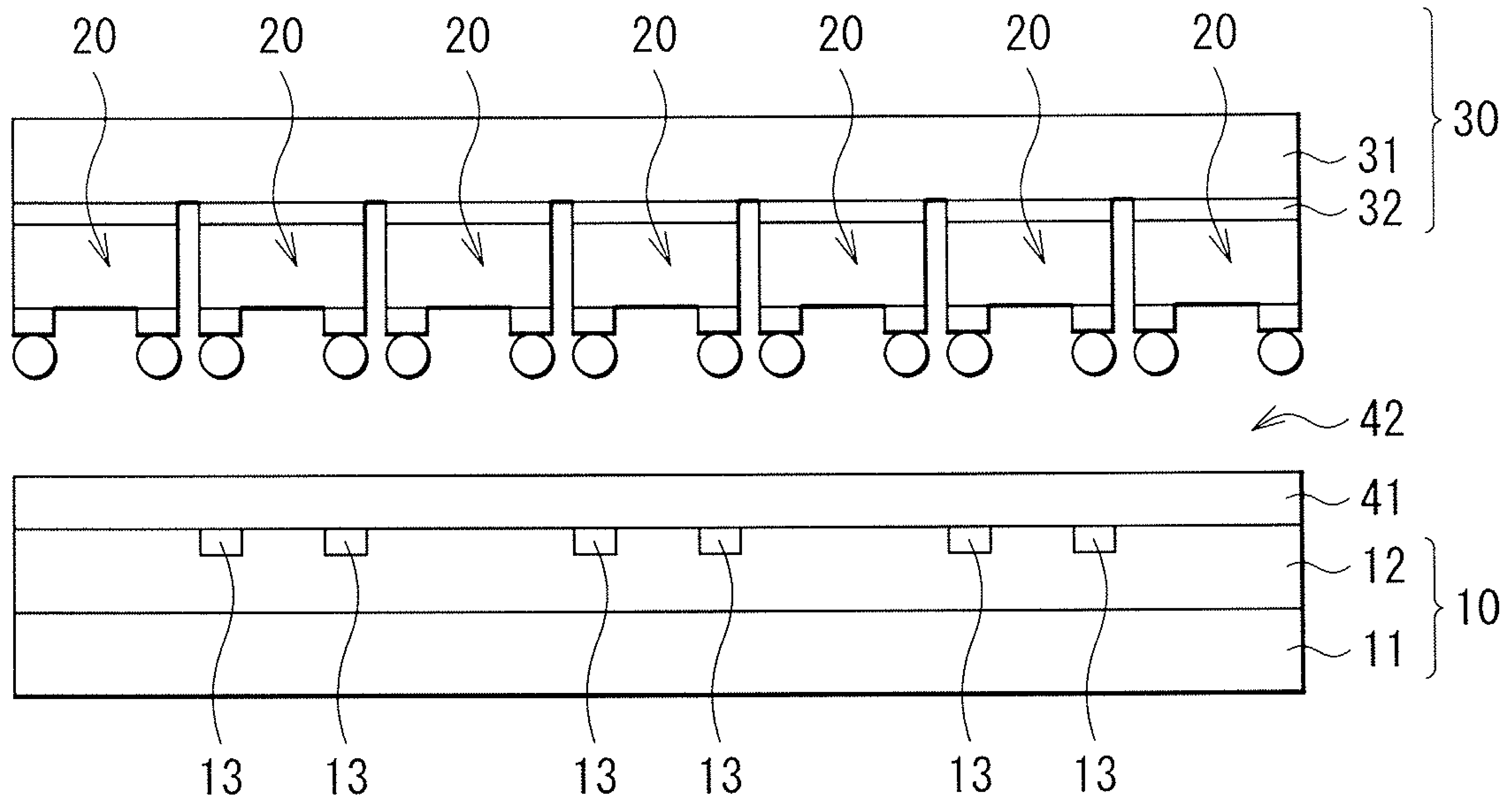

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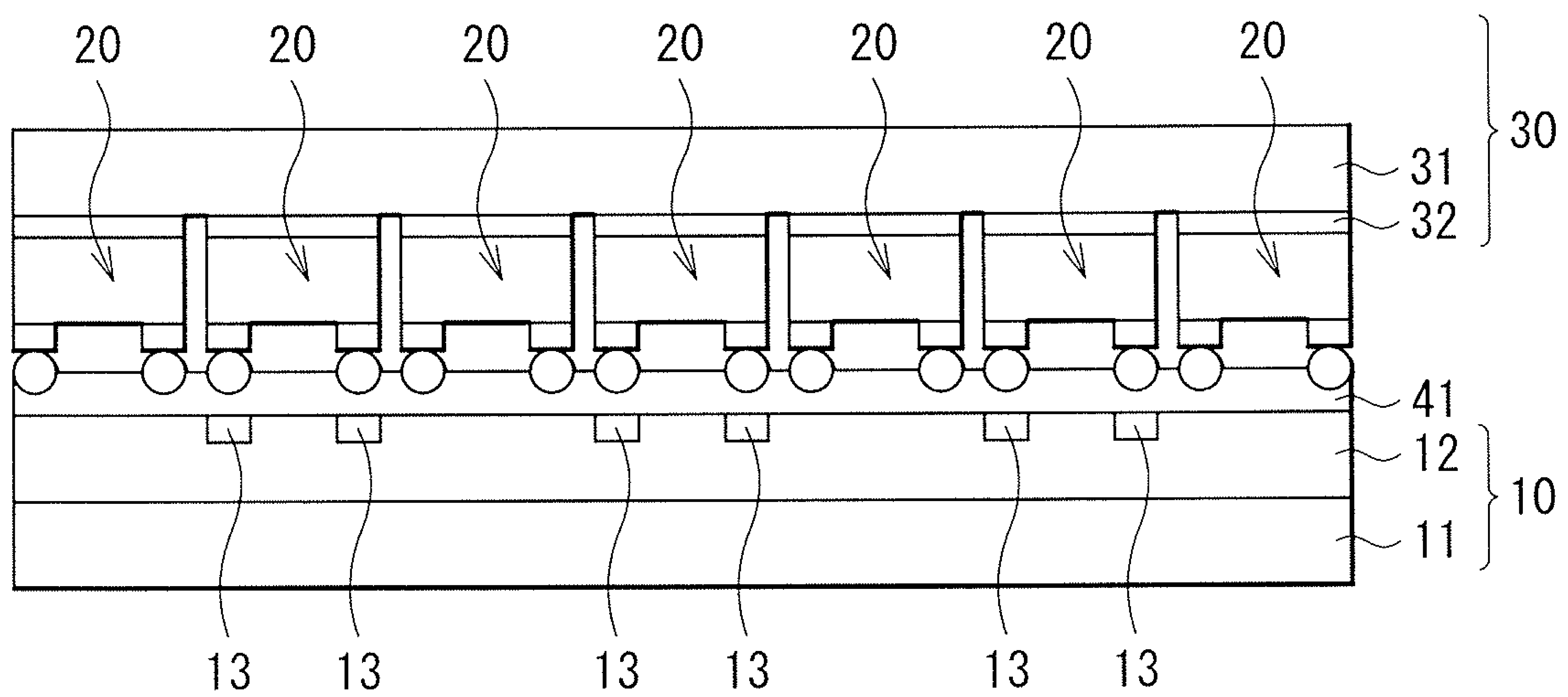

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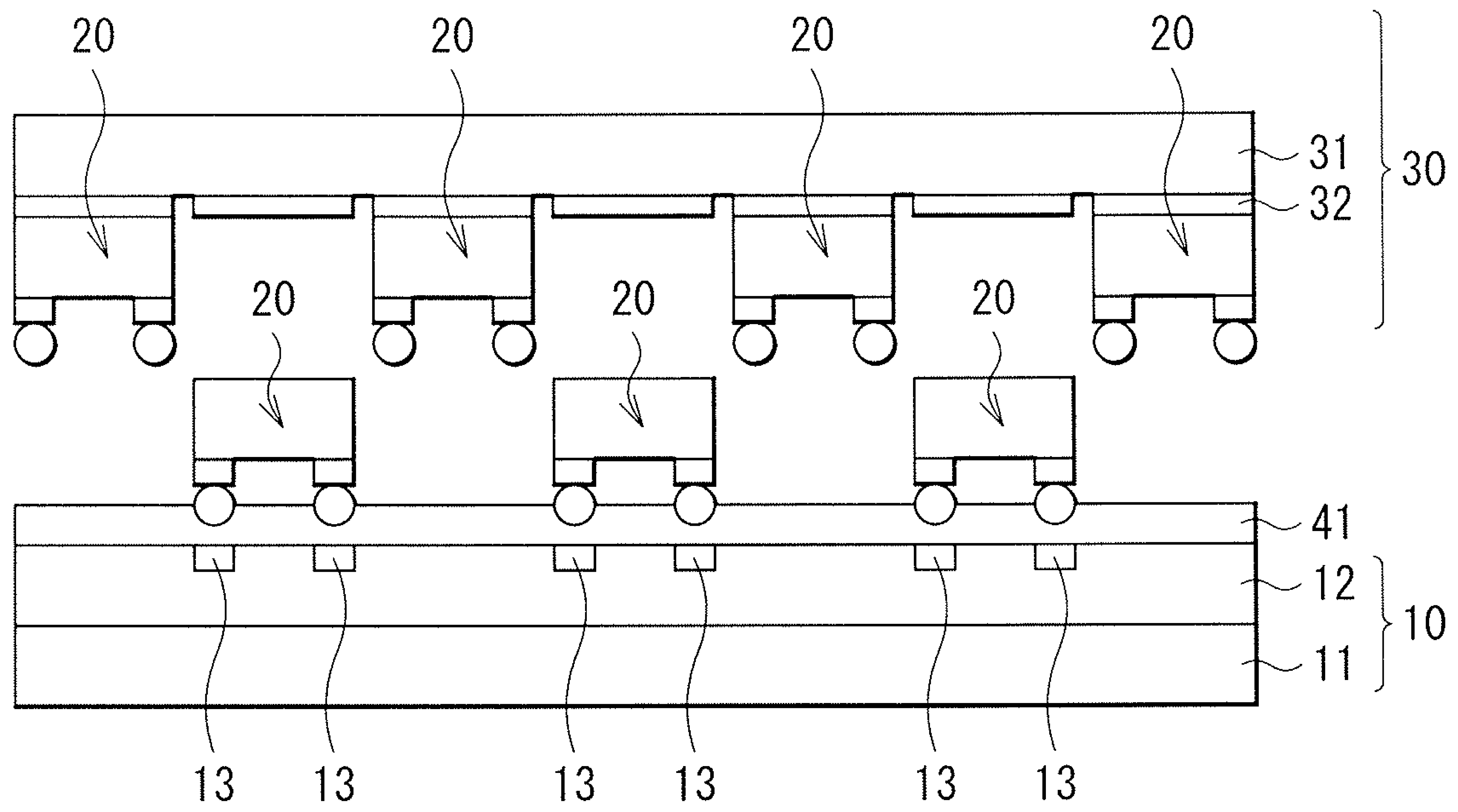
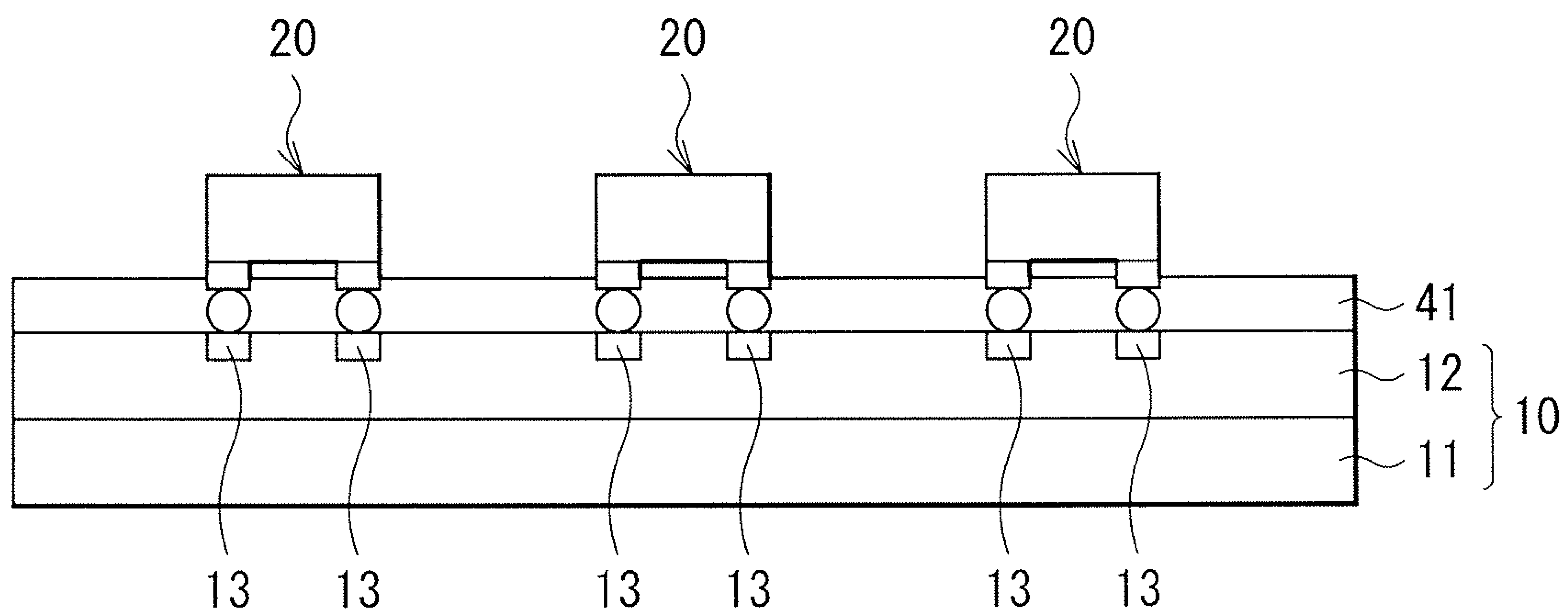


FIG. 9



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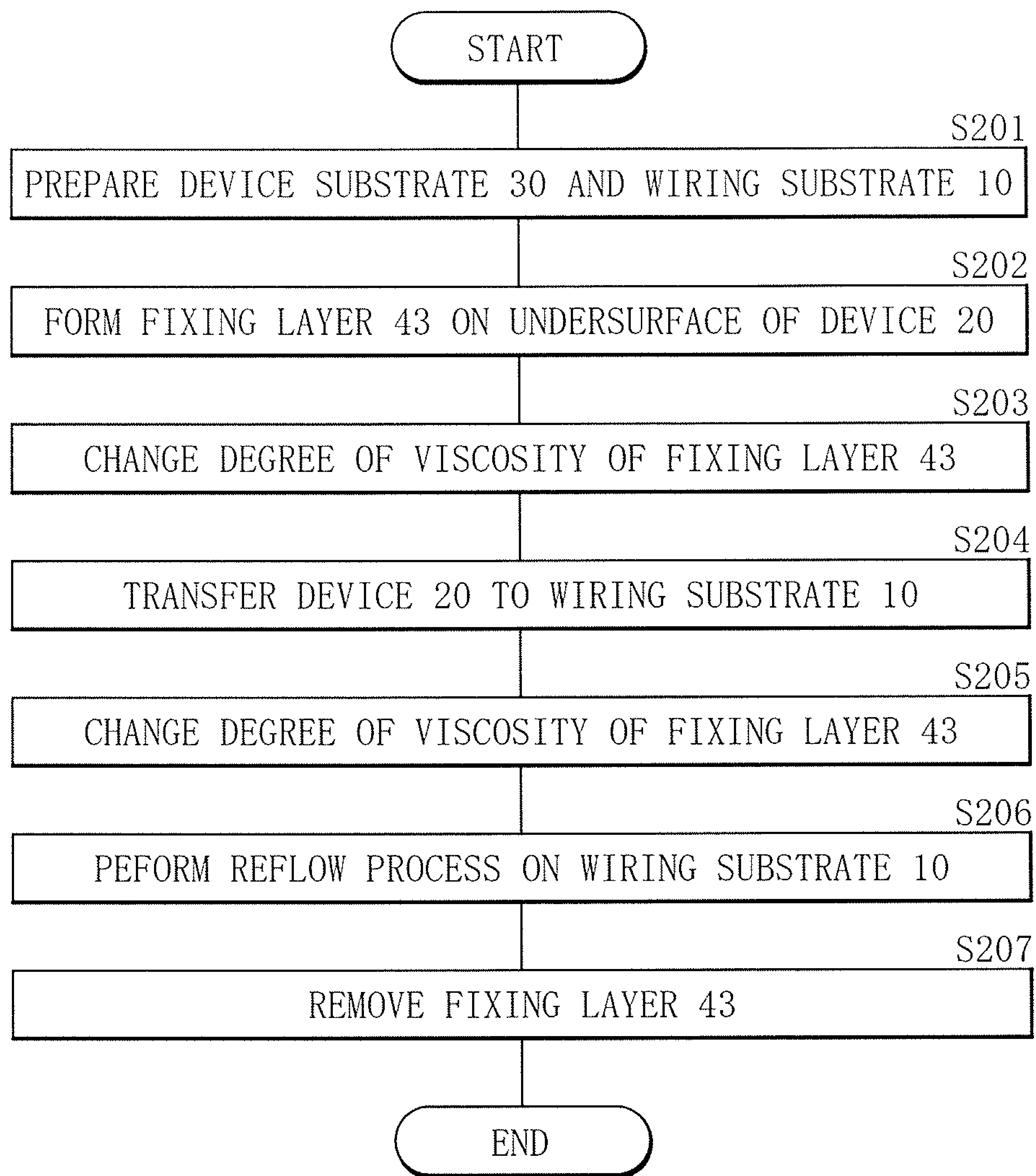

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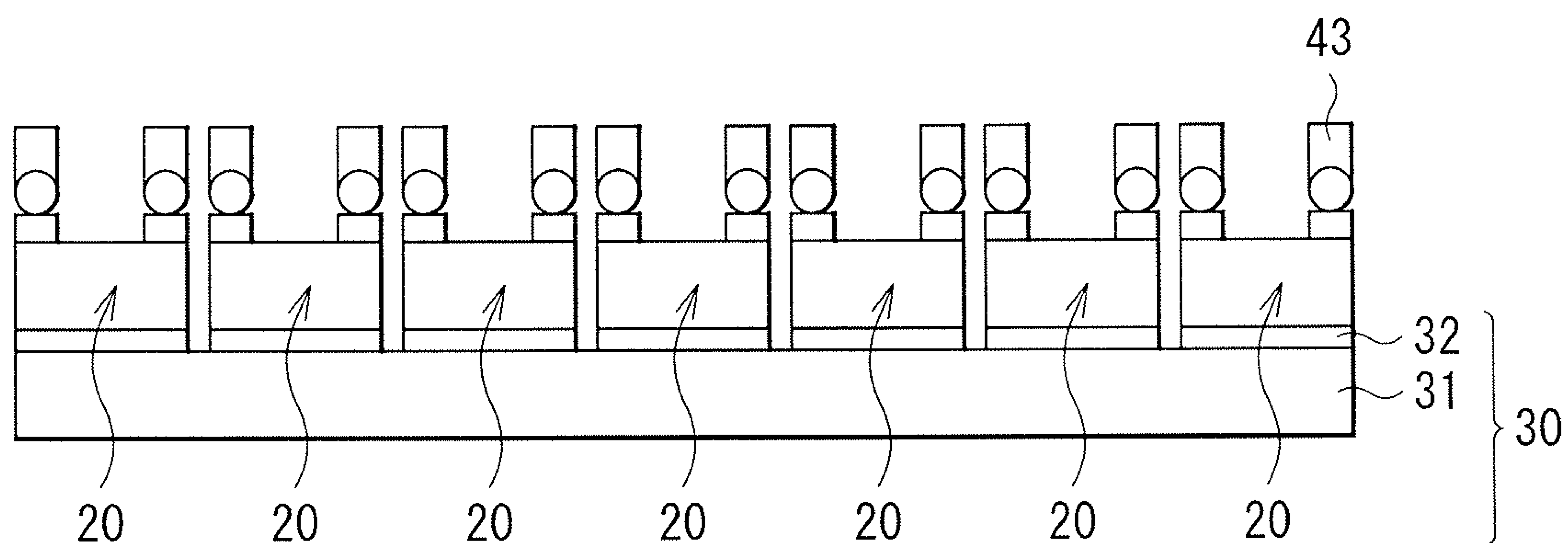


FIG. 12

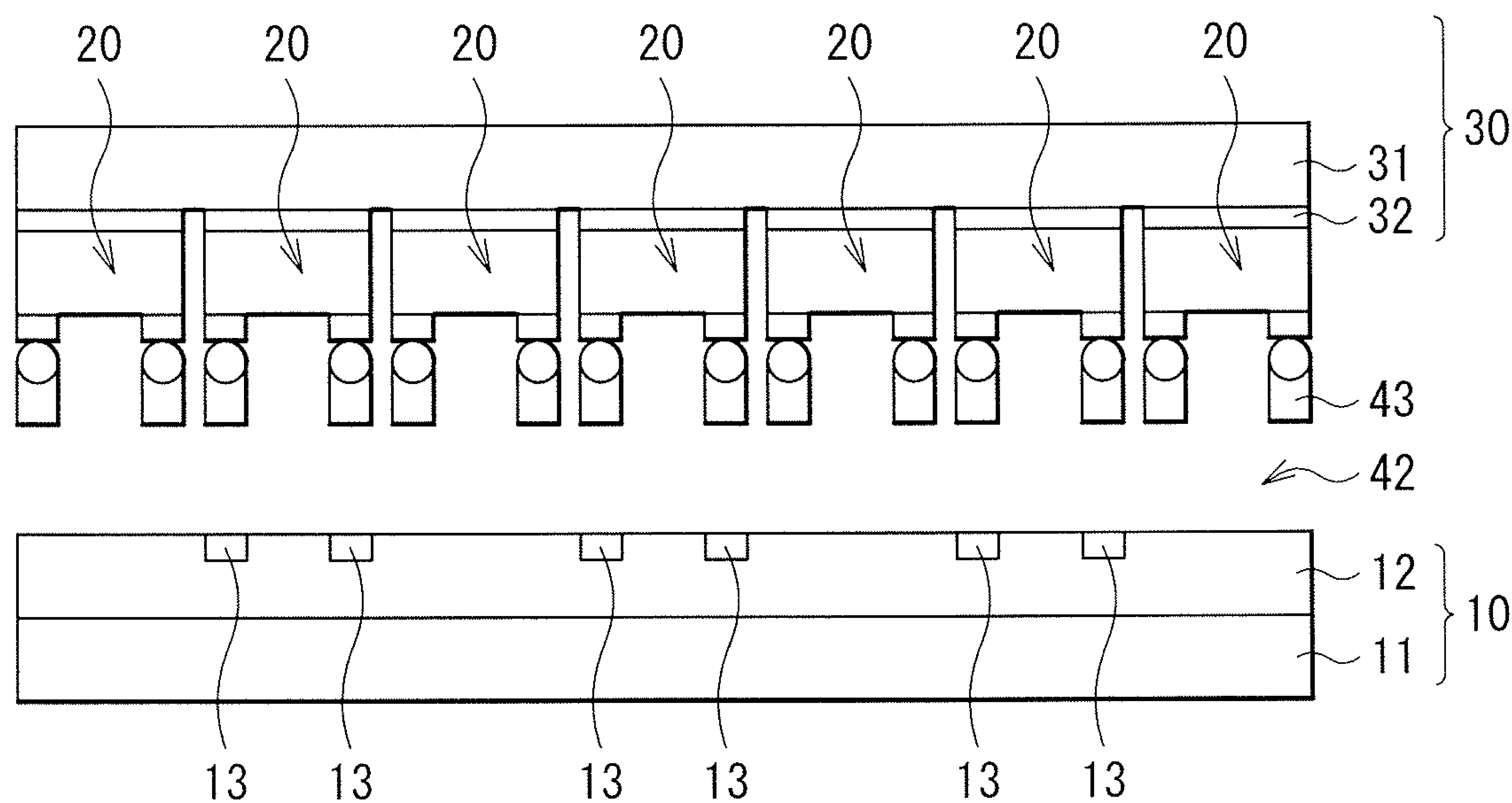


FIG. 13

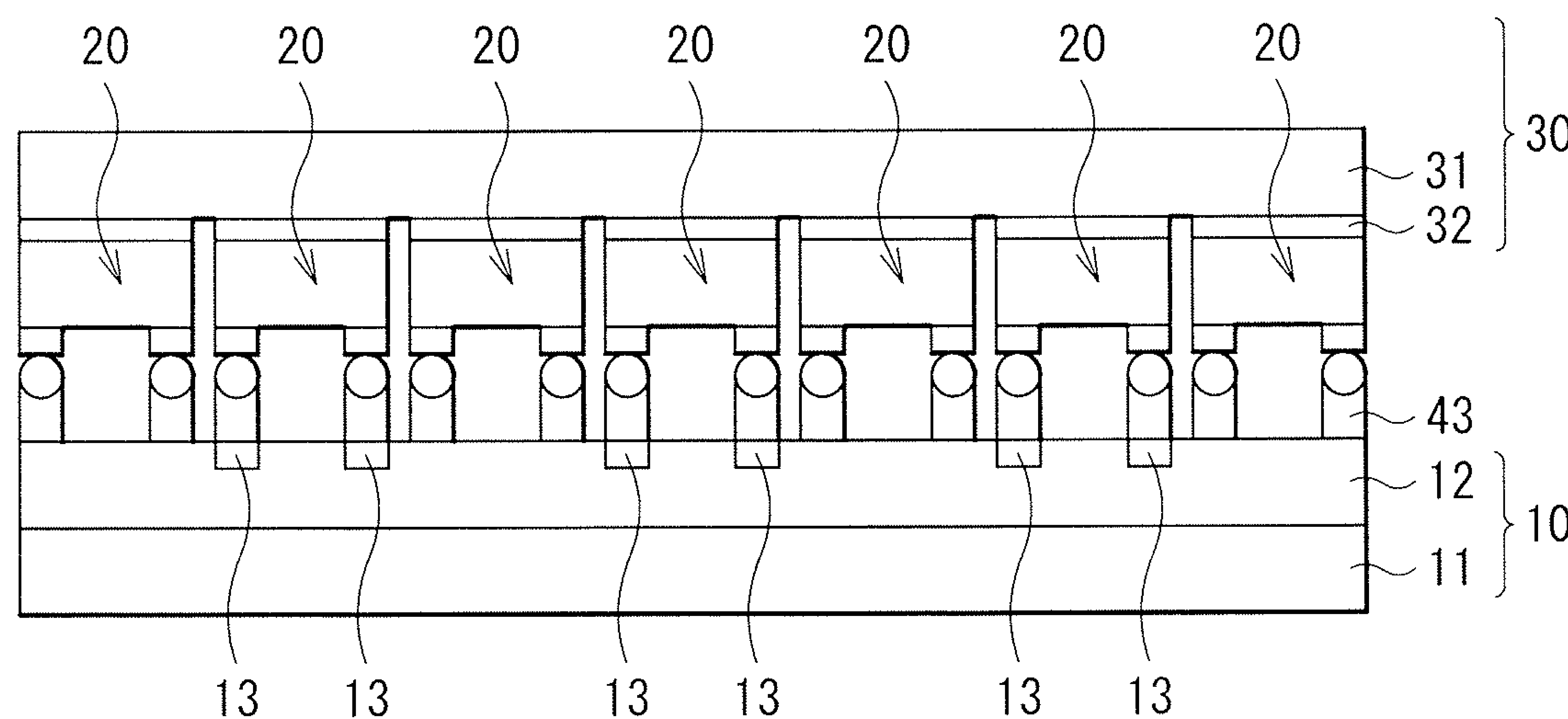


FIG. 14

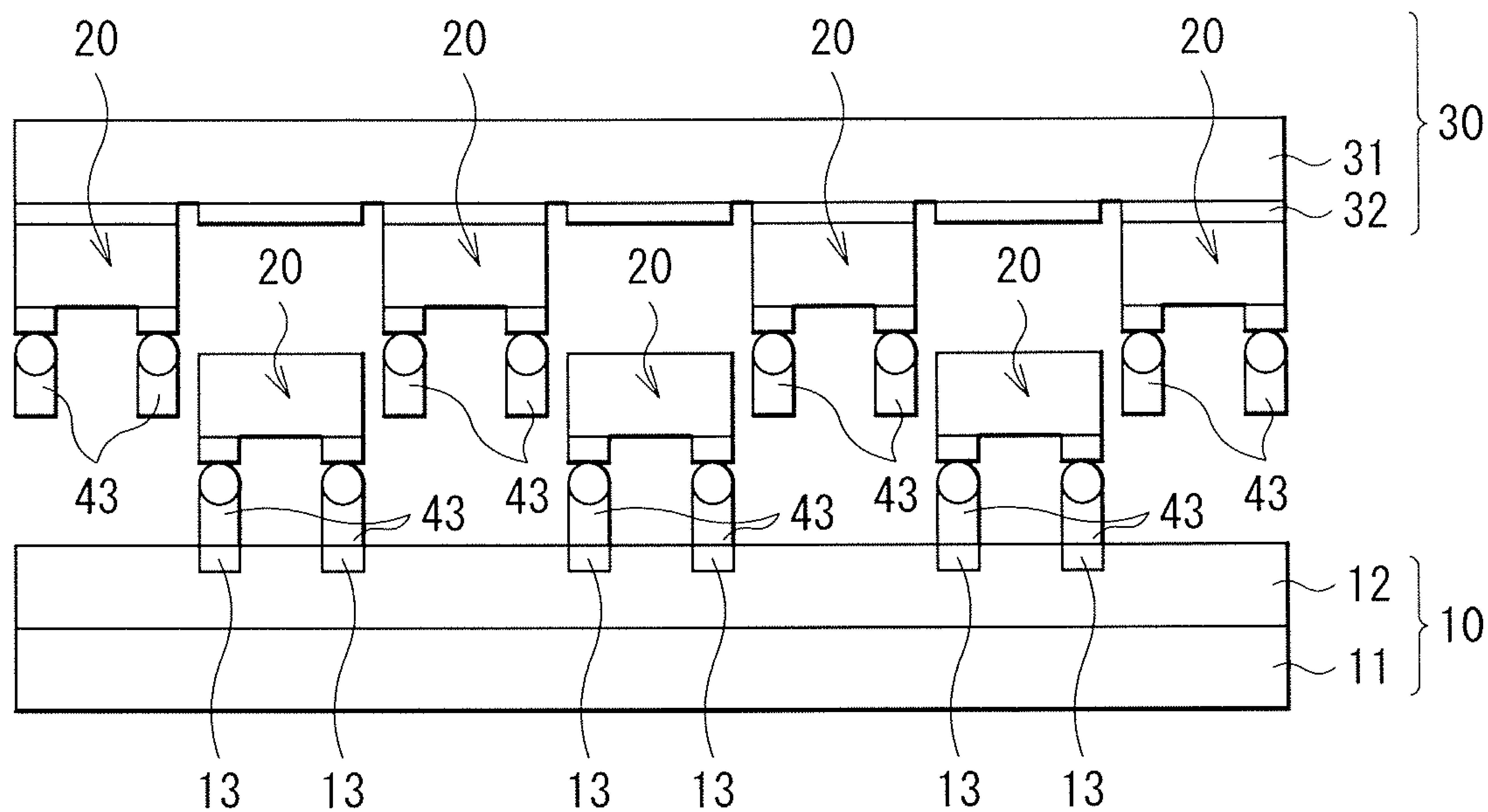


FIG. 15

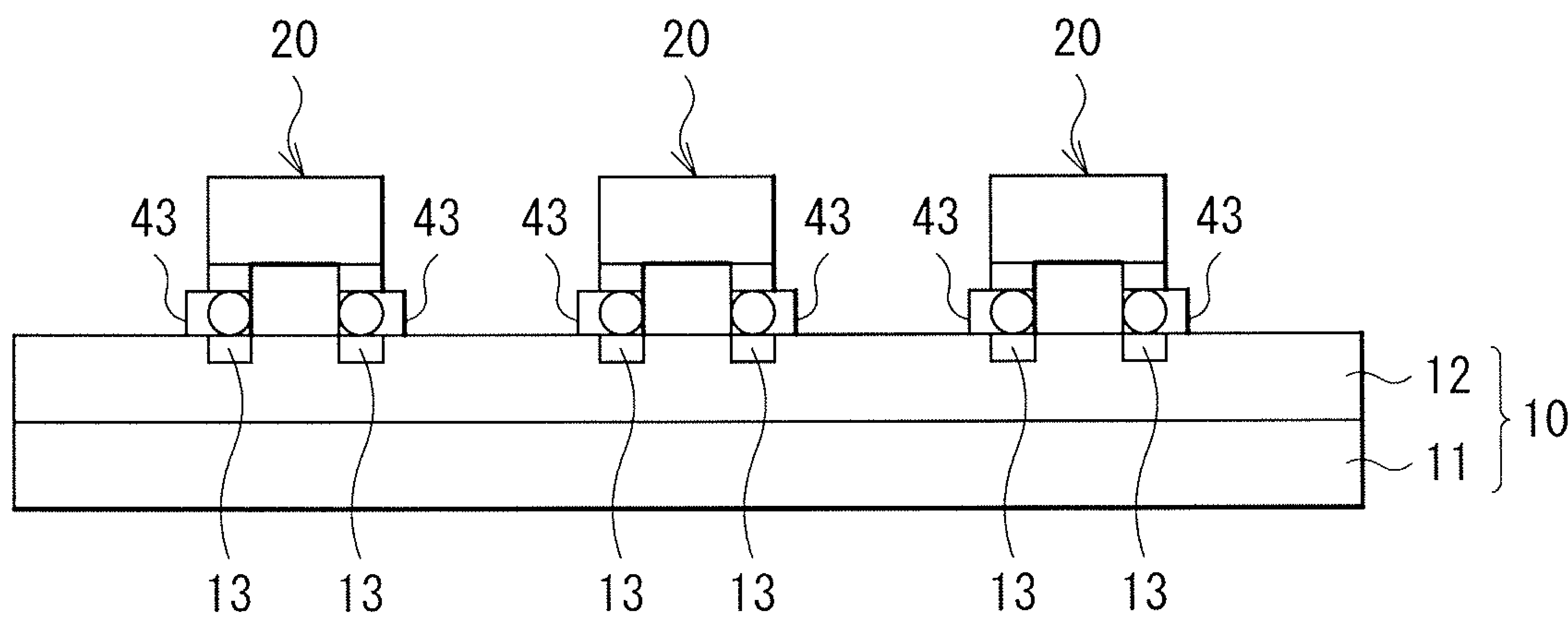


FIG. 16

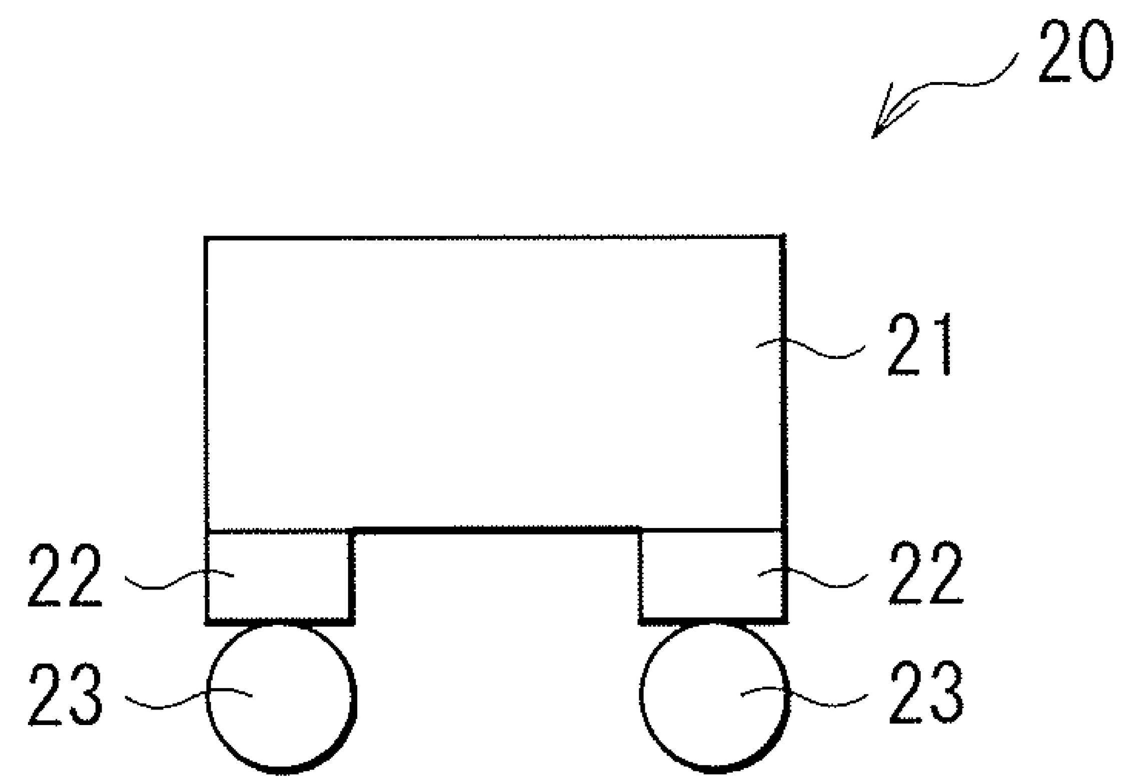


FIG. 17A

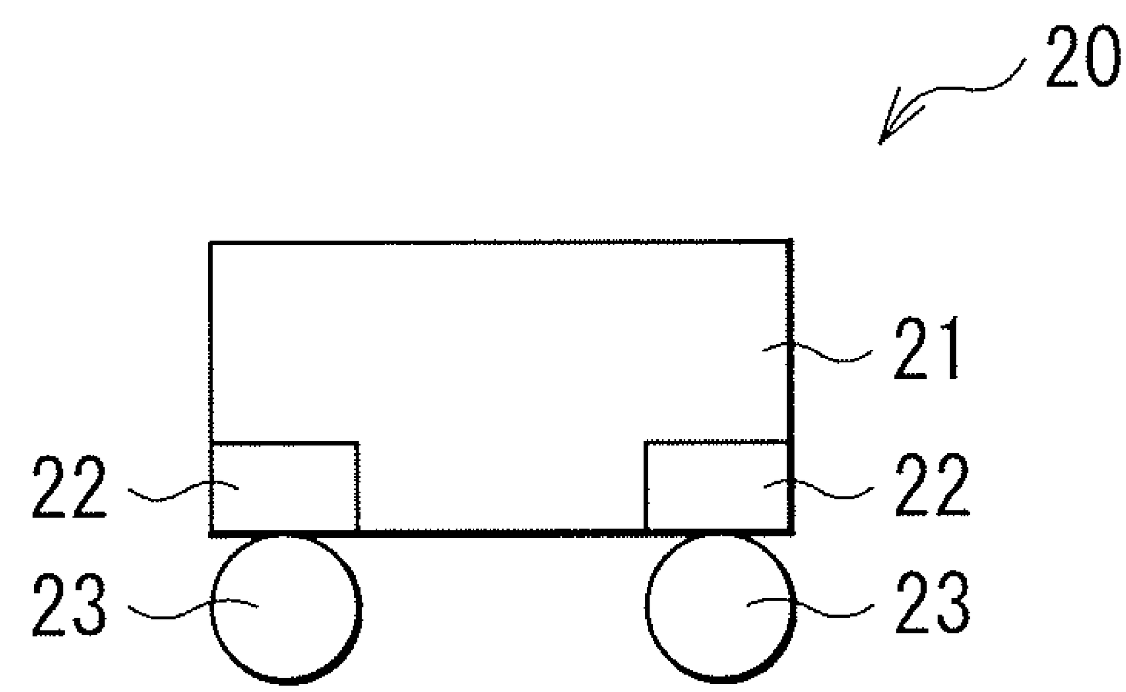


FIG. 17B

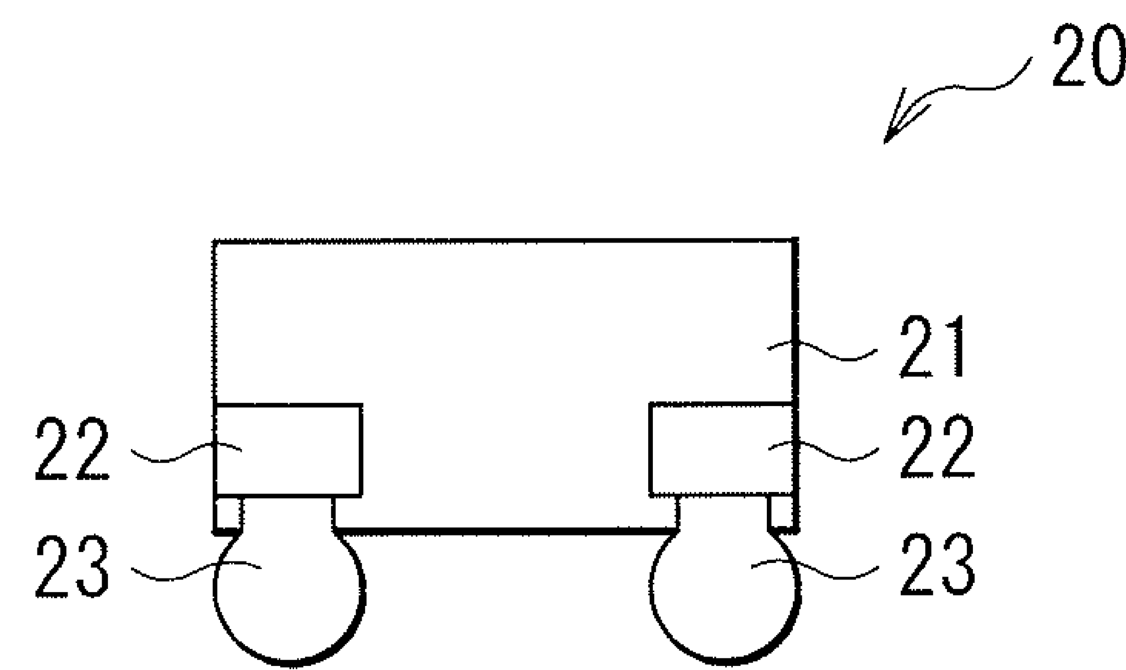


FIG. 17C

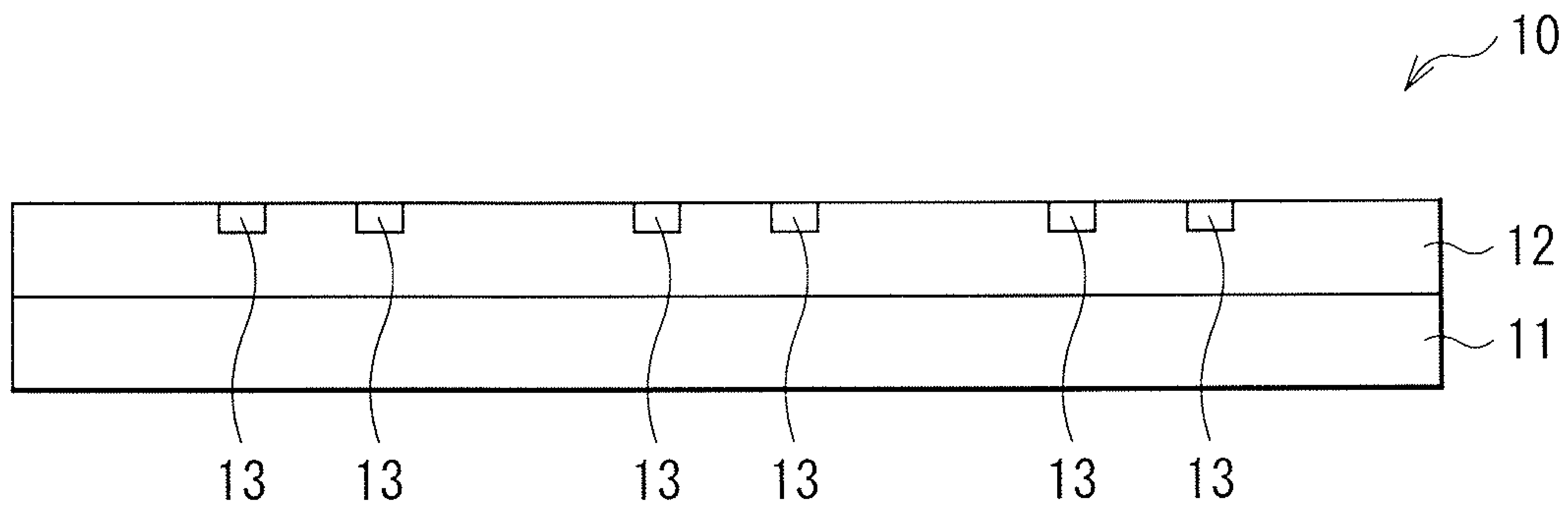


FIG. 18A

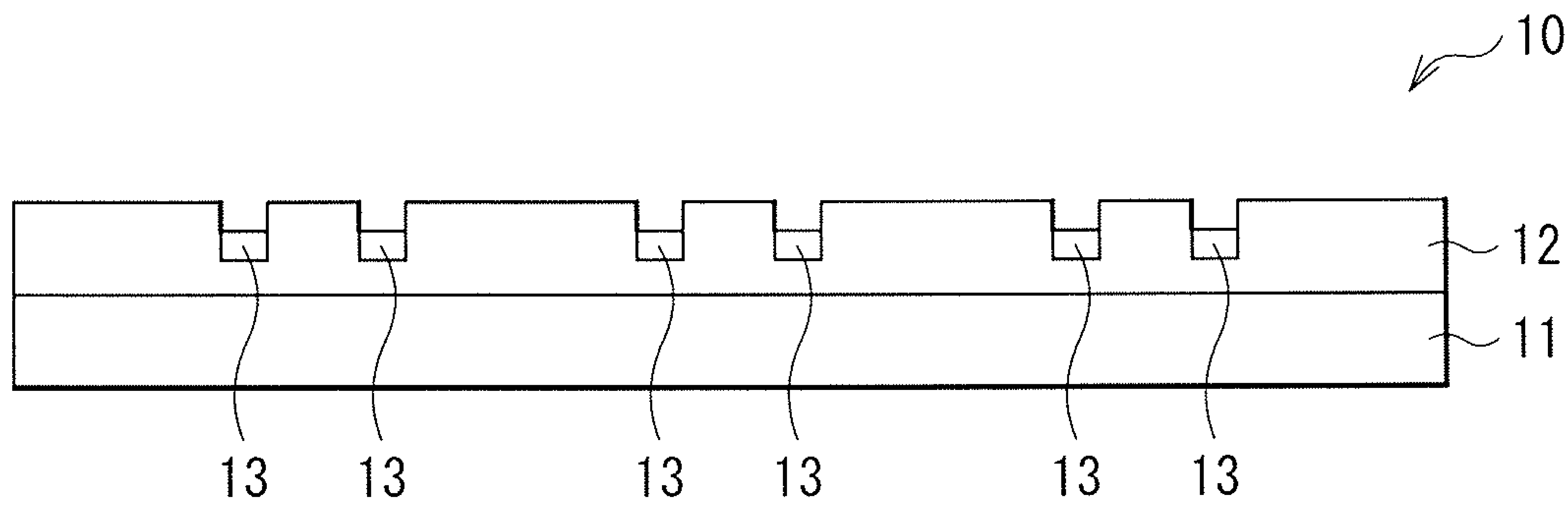


FIG. 18B

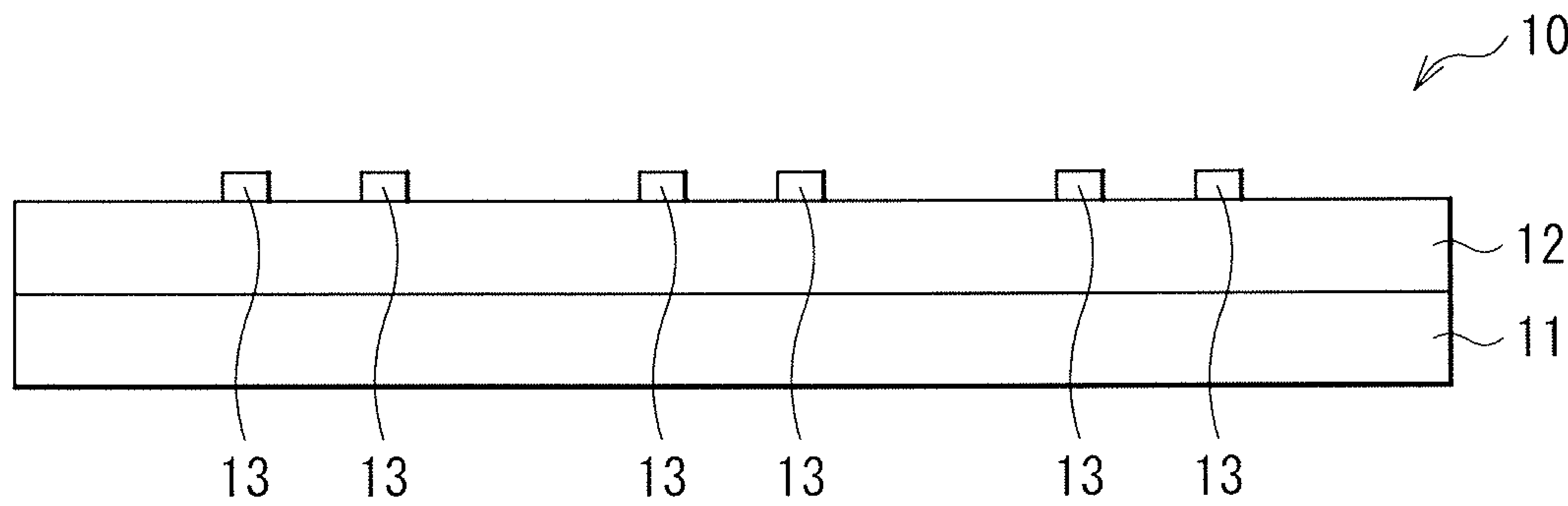


FIG. 18C

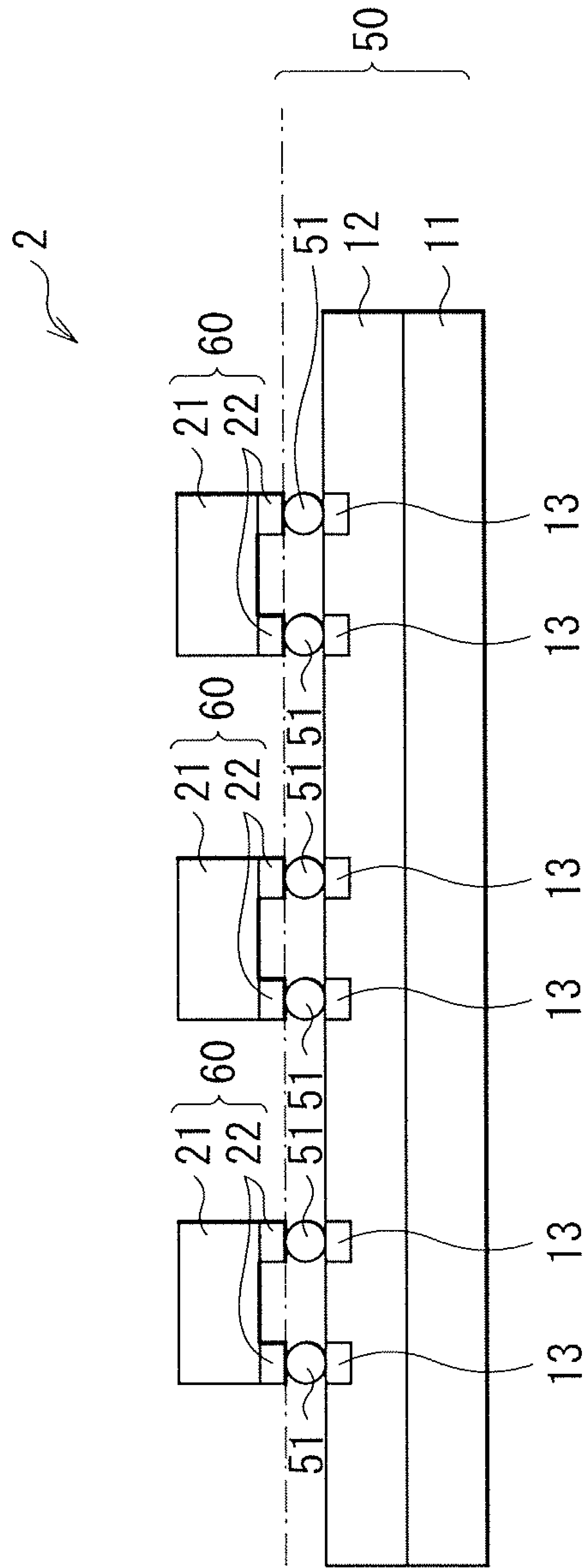


FIG. 19

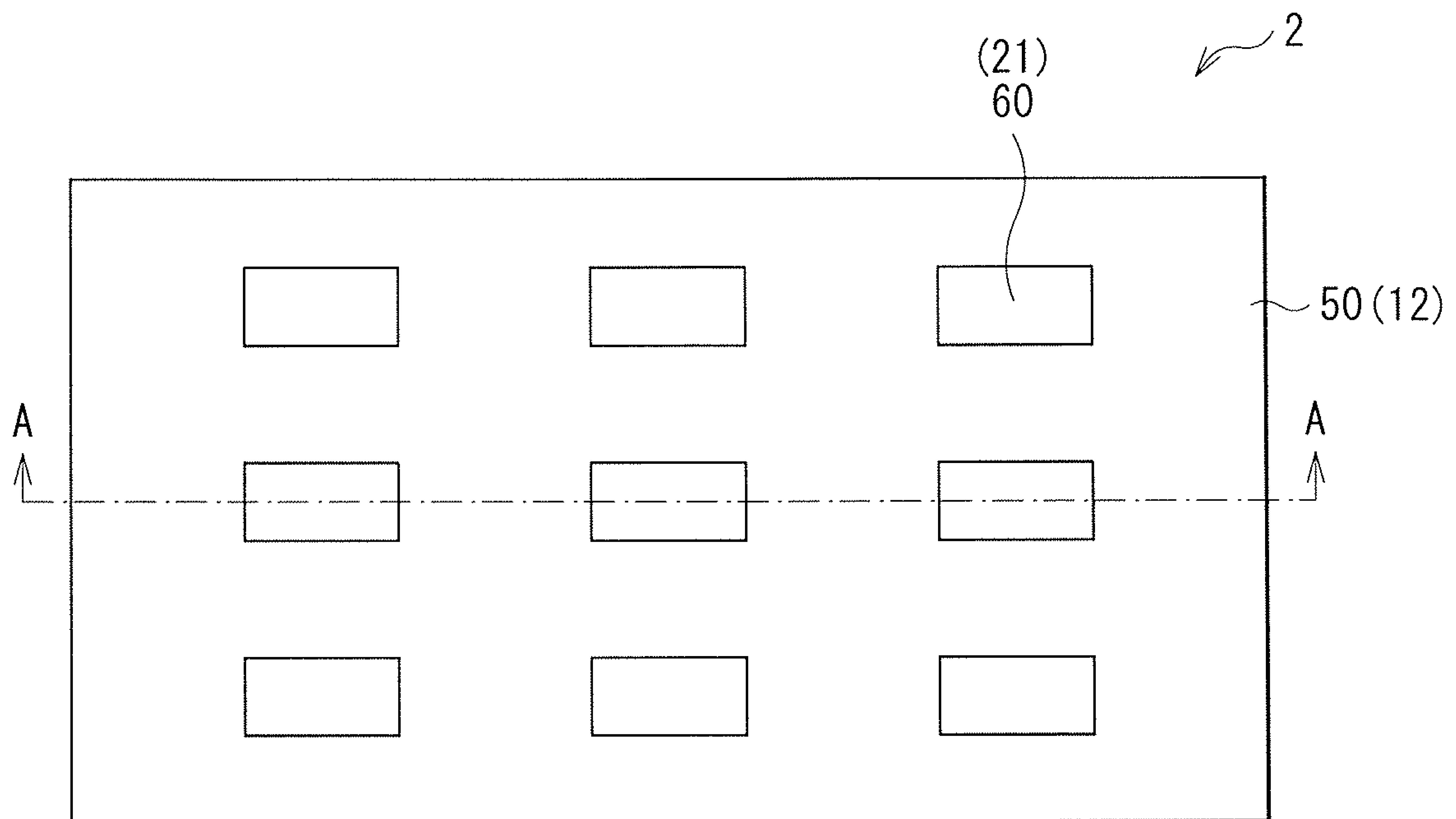


FIG. 20

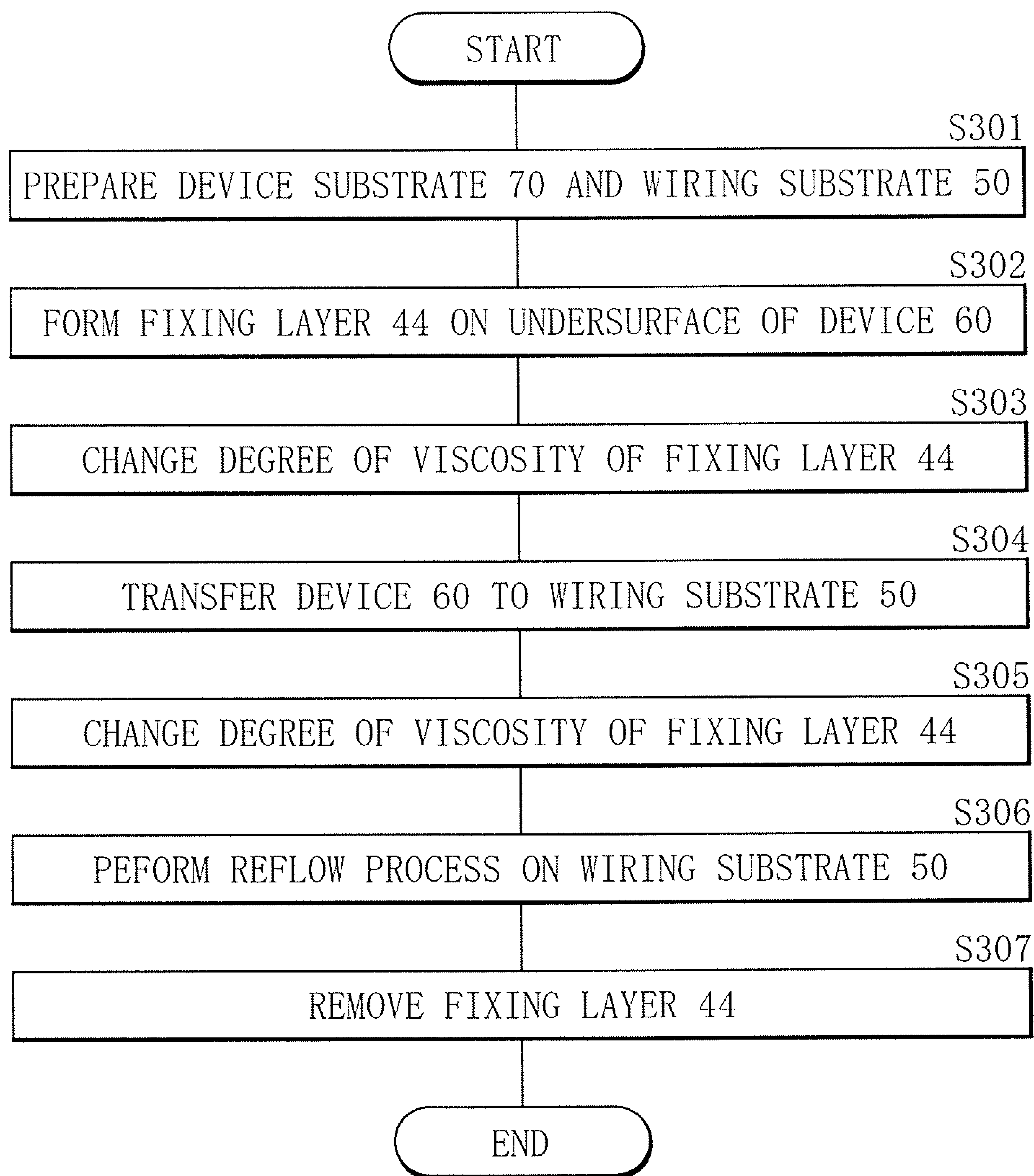


FIG. 21

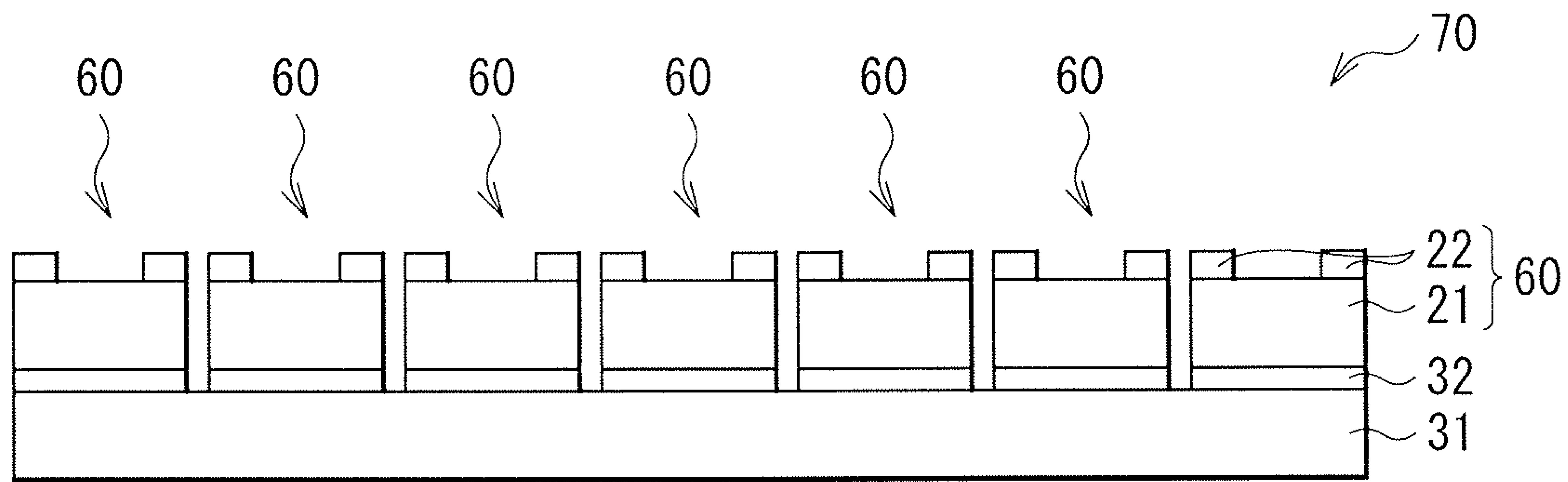


FIG. 22

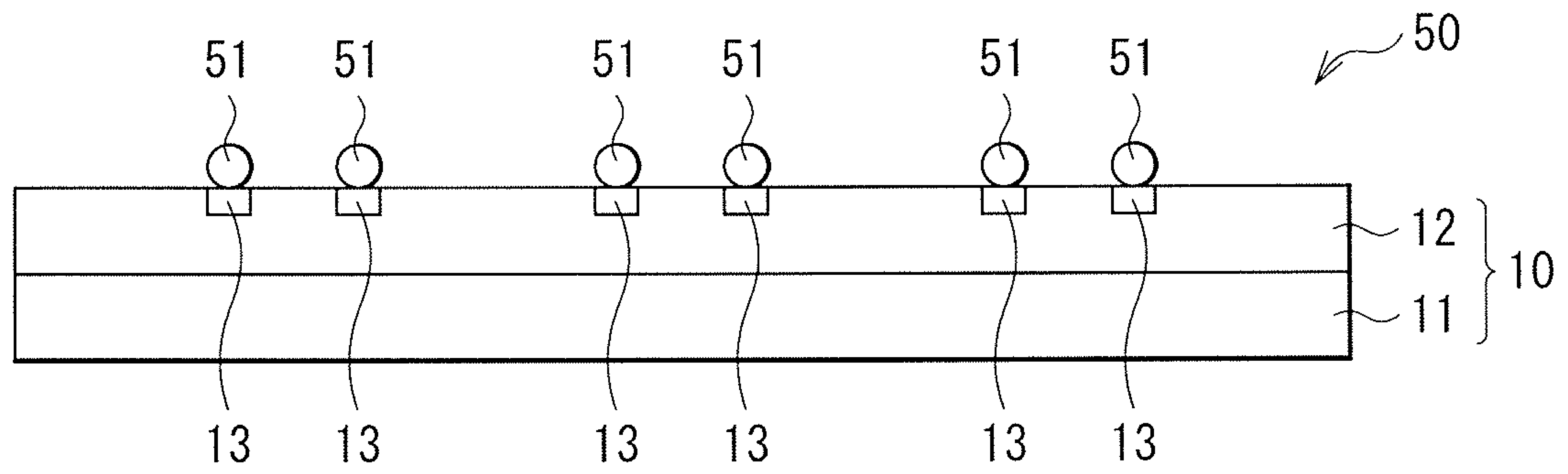


FIG. 23

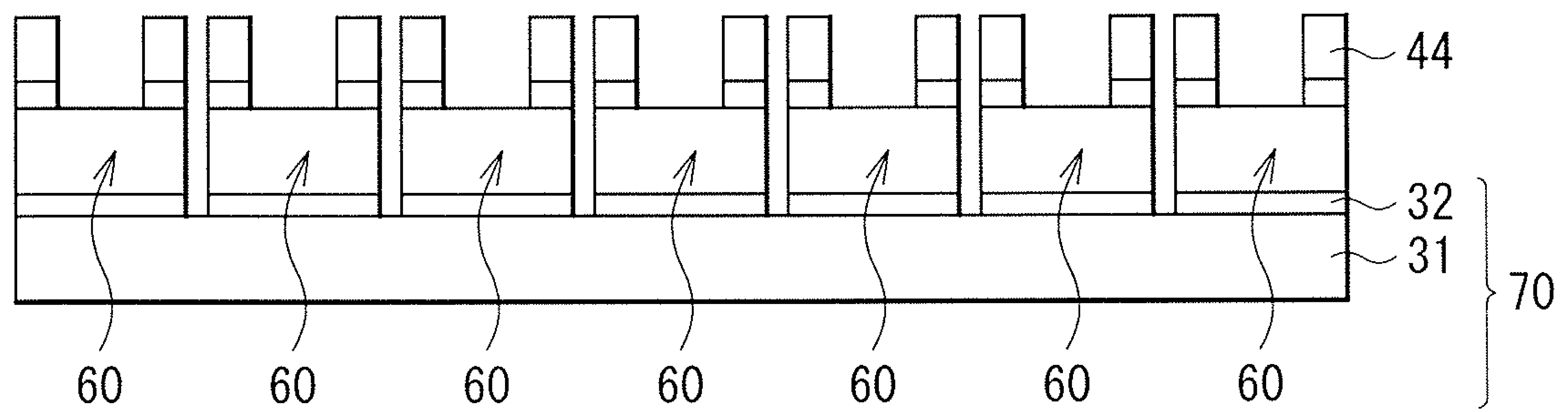


FIG. 24

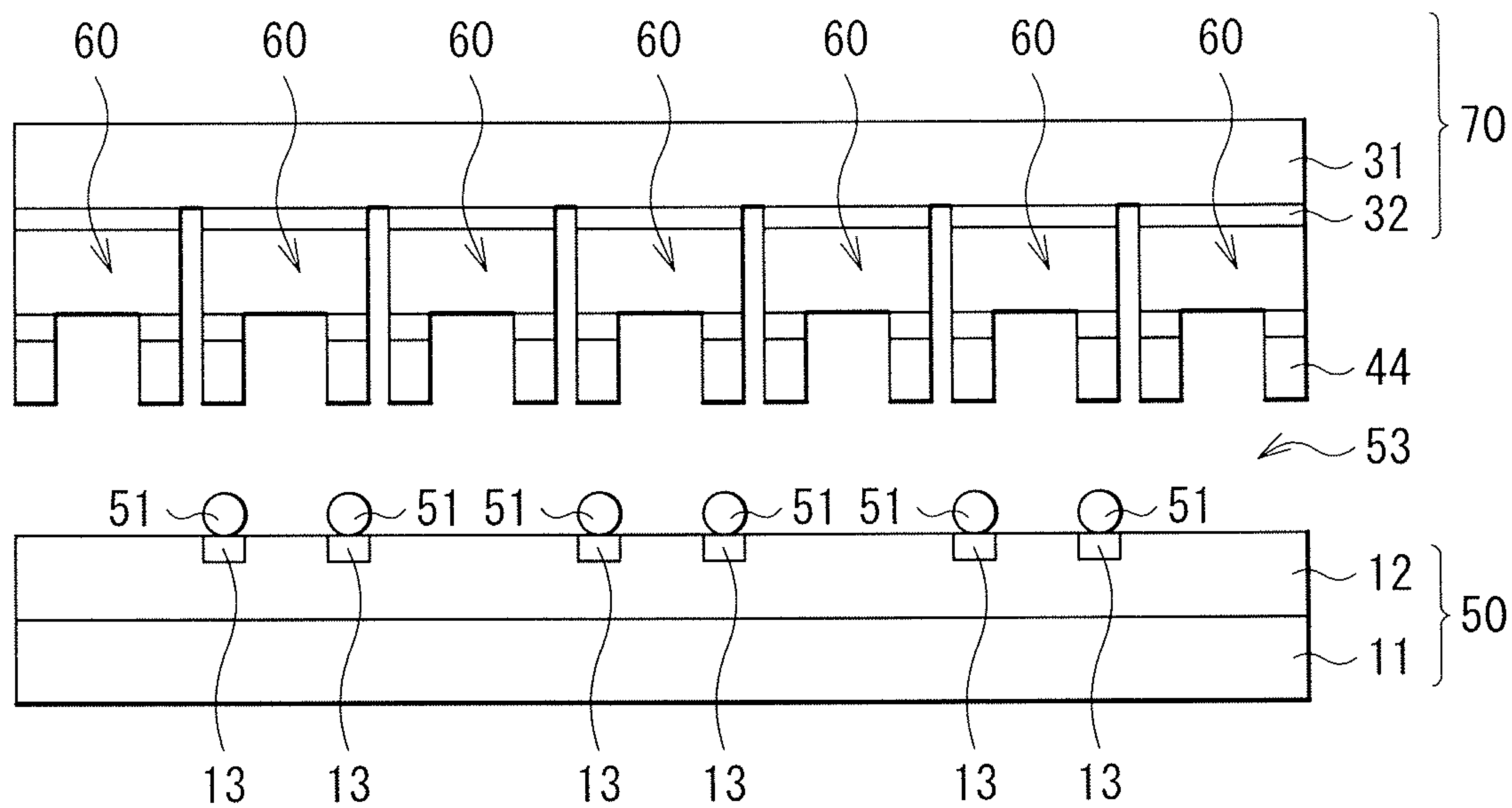


FIG. 25

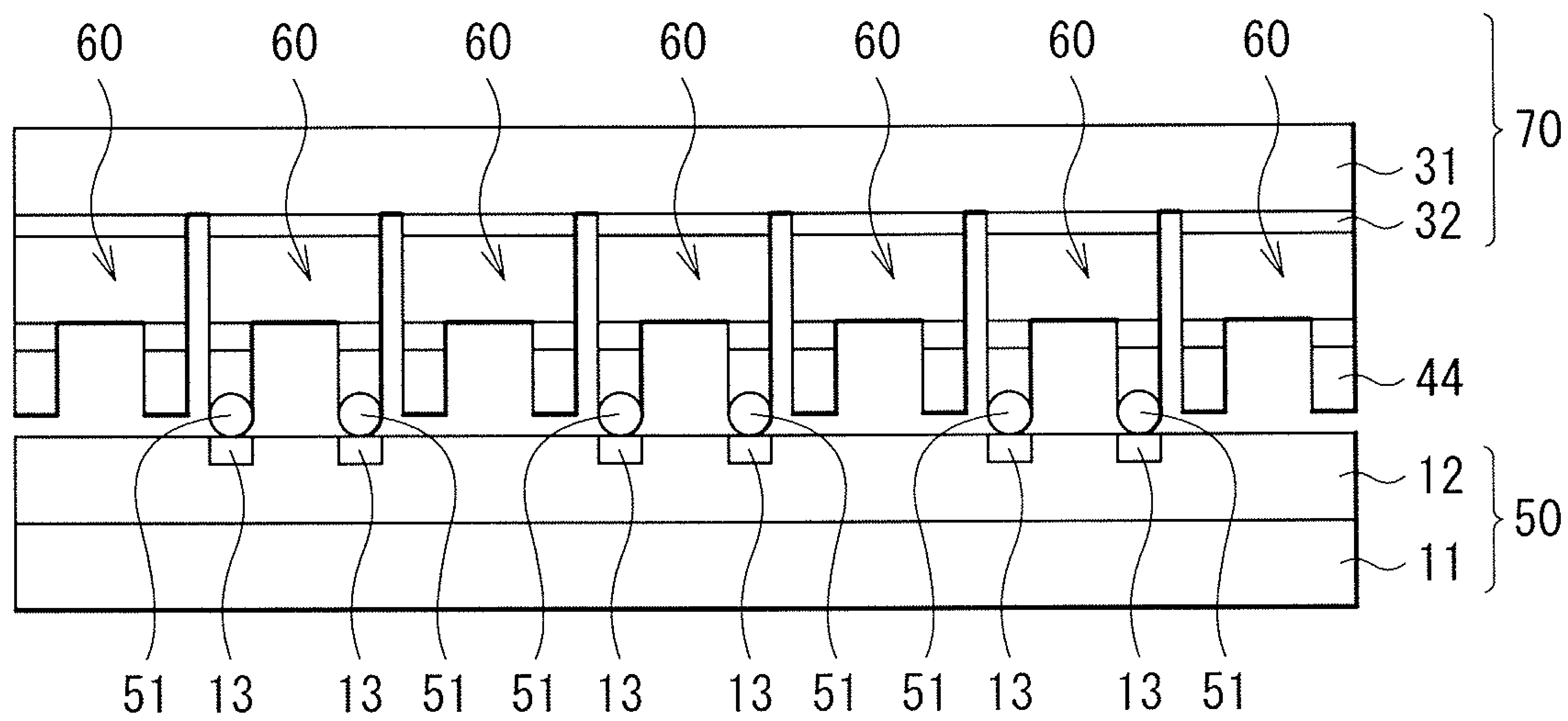


FIG. 26

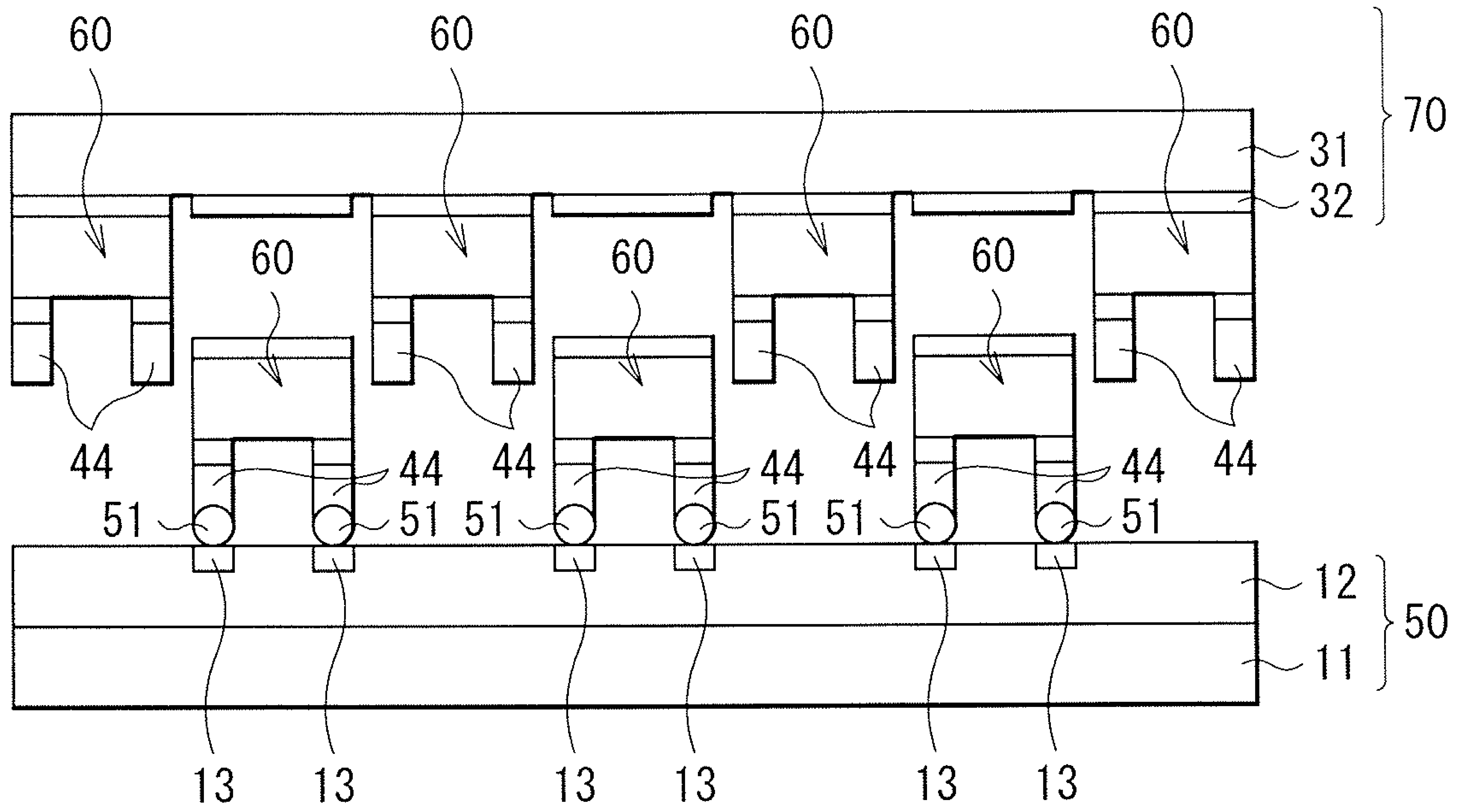


FIG. 27

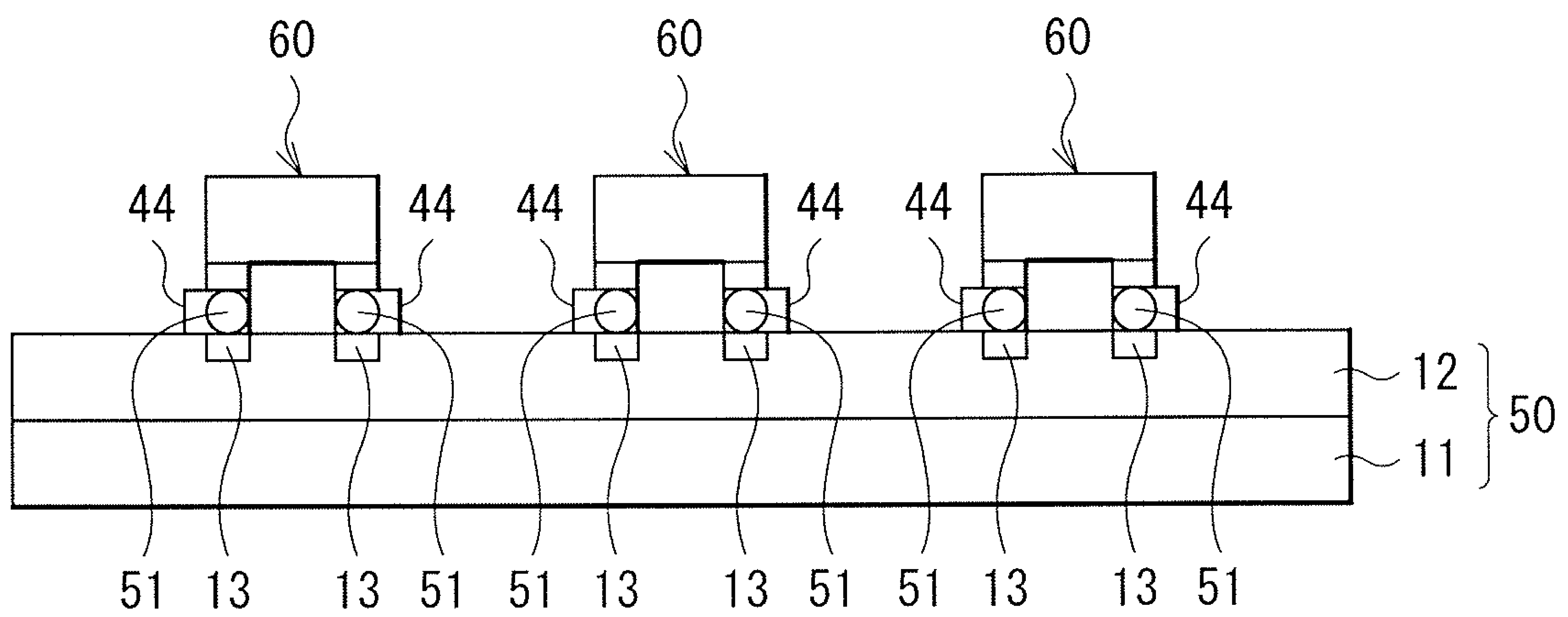


FIG. 28

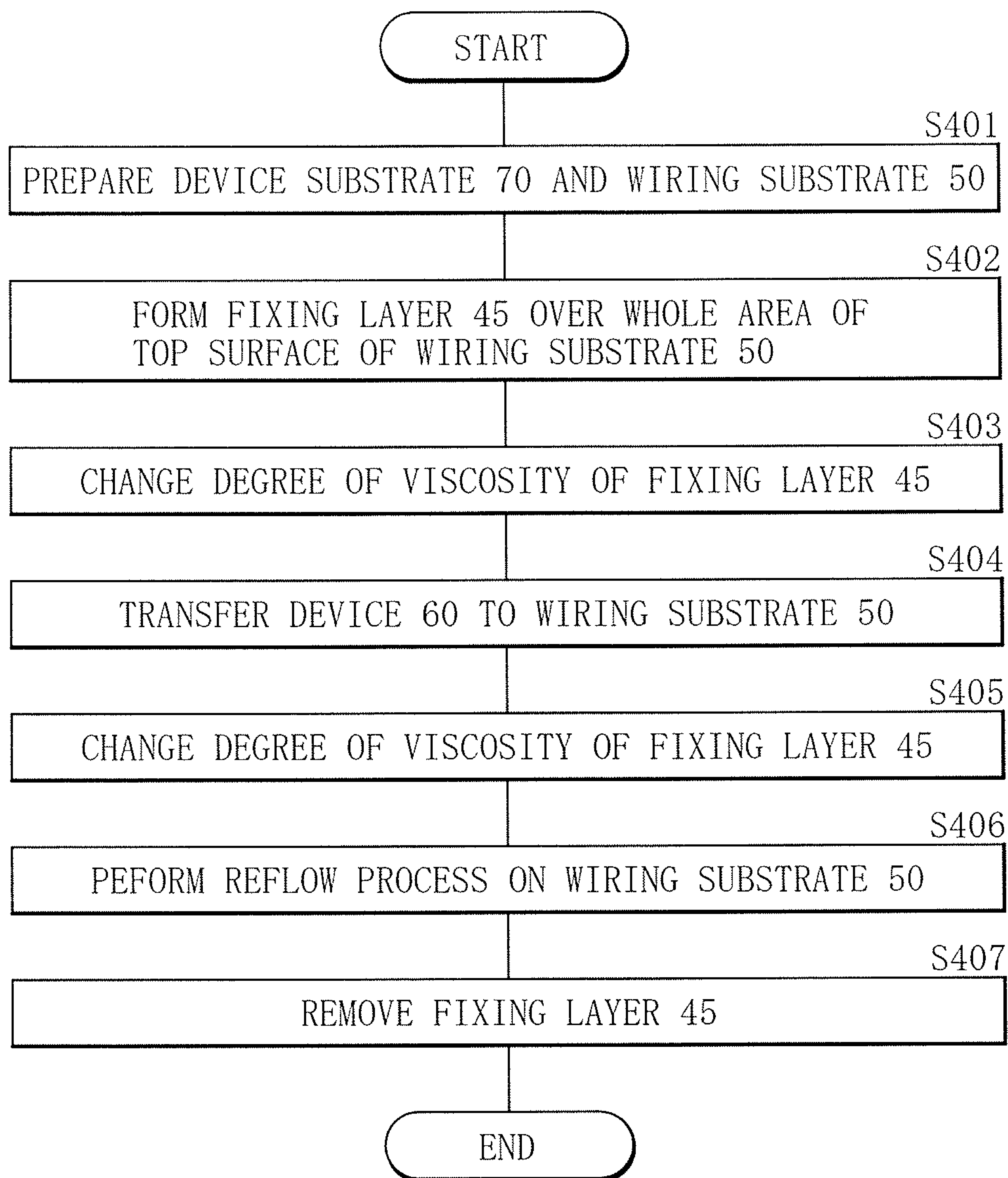


FIG. 29

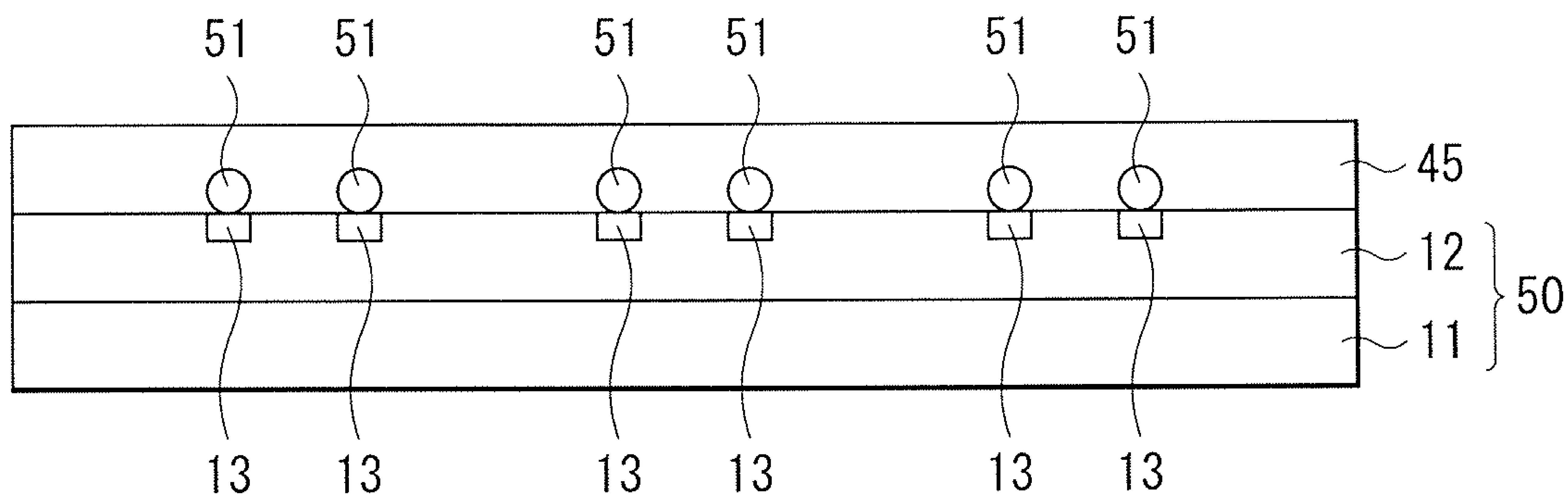


FIG. 30

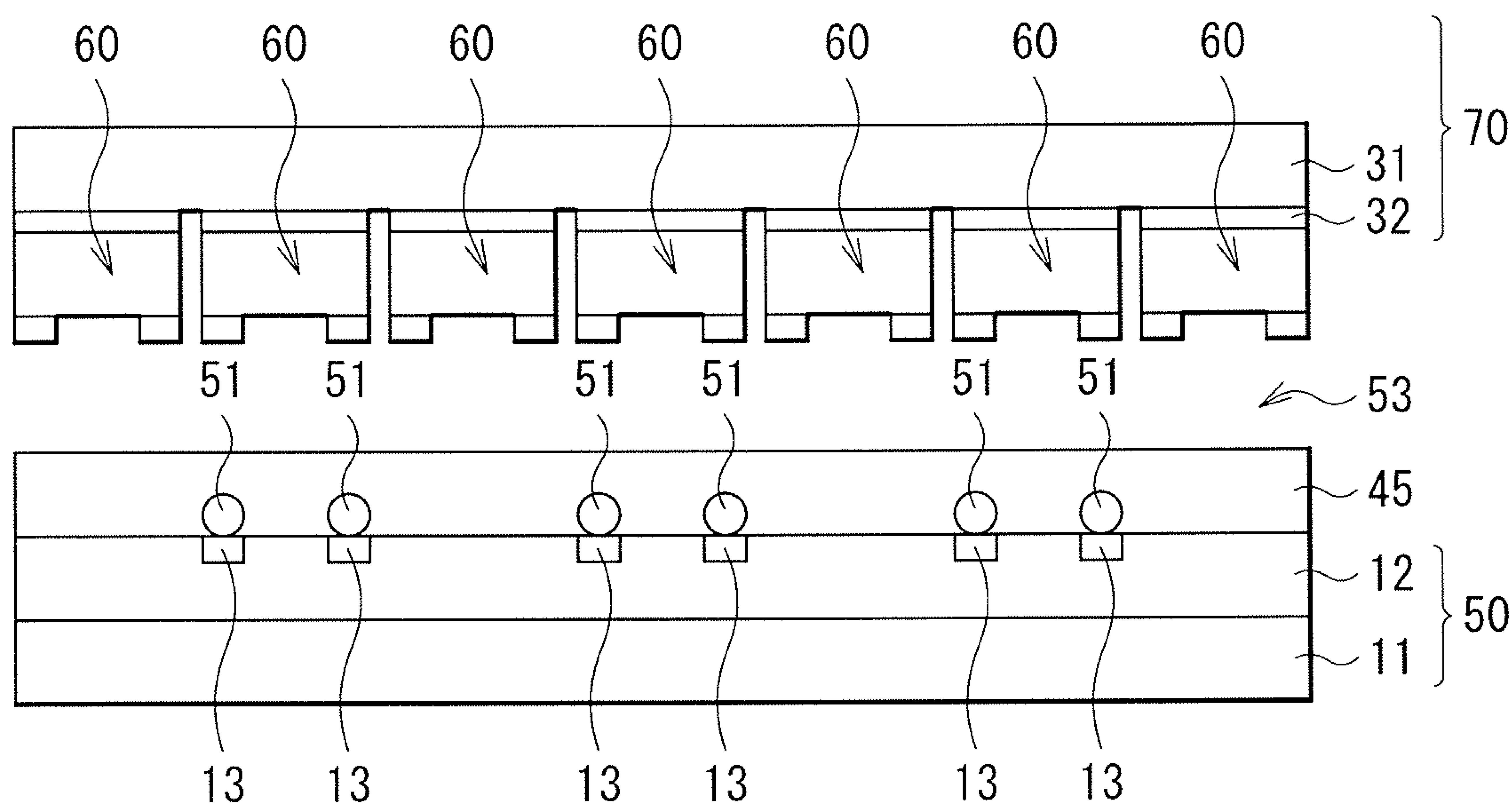


FIG. 31

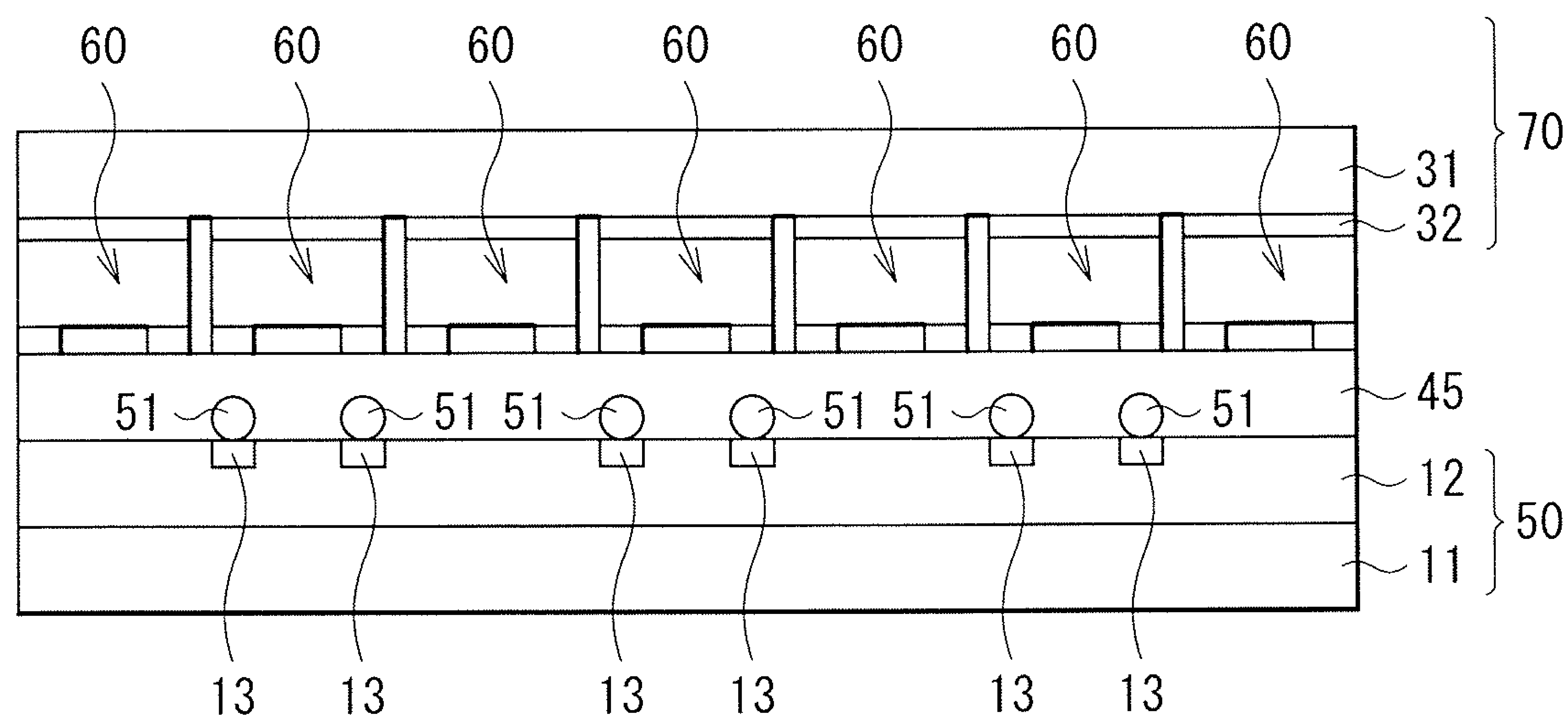


FIG. 32

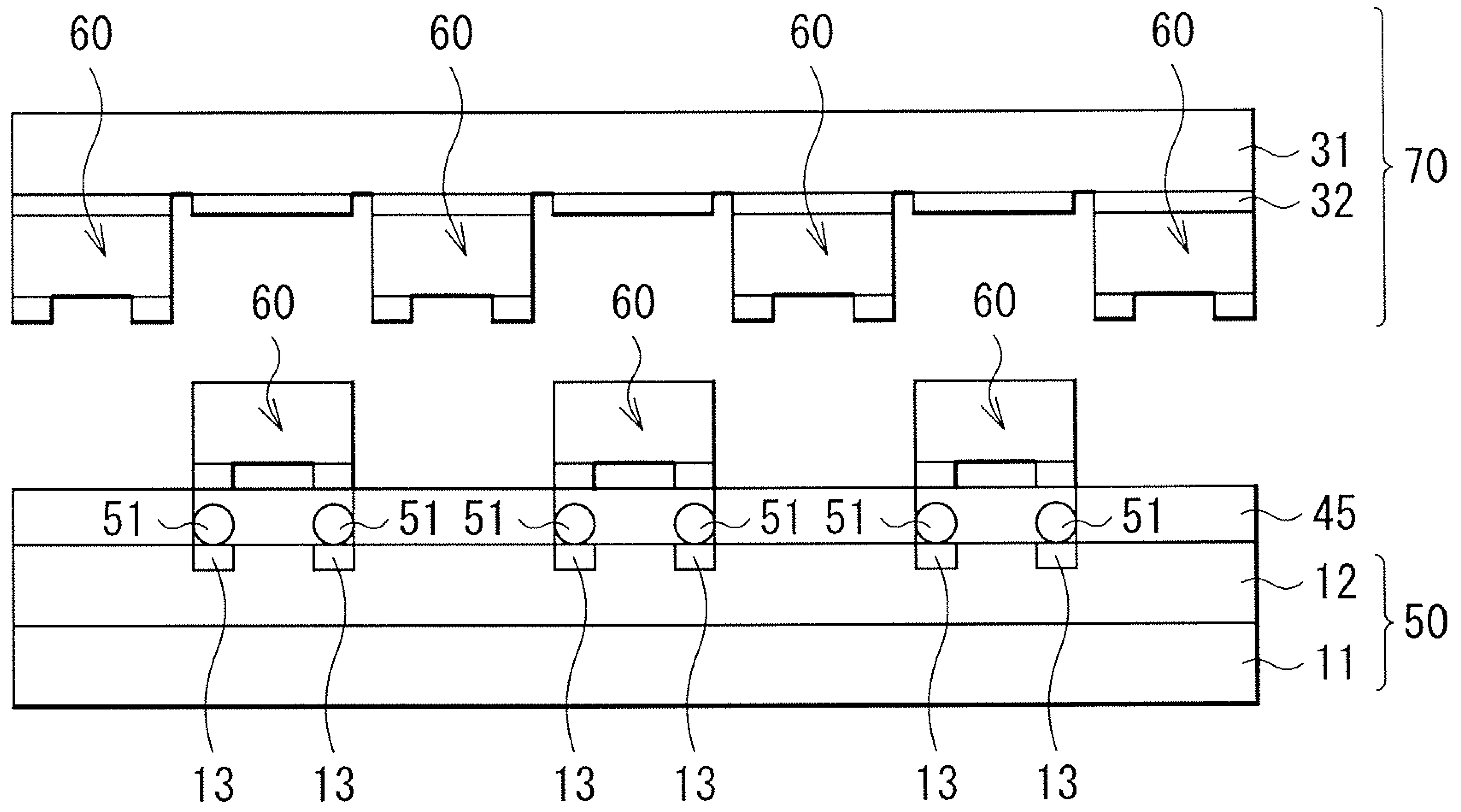


FIG. 33

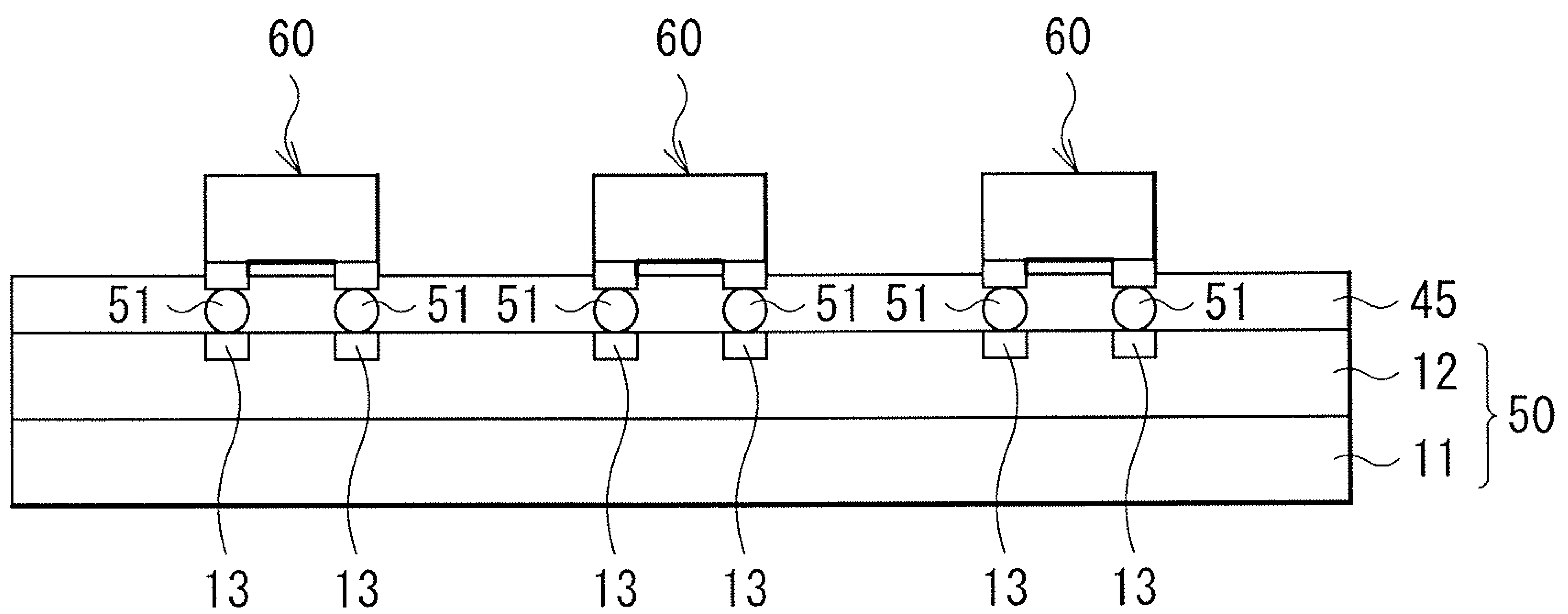


FIG. 34

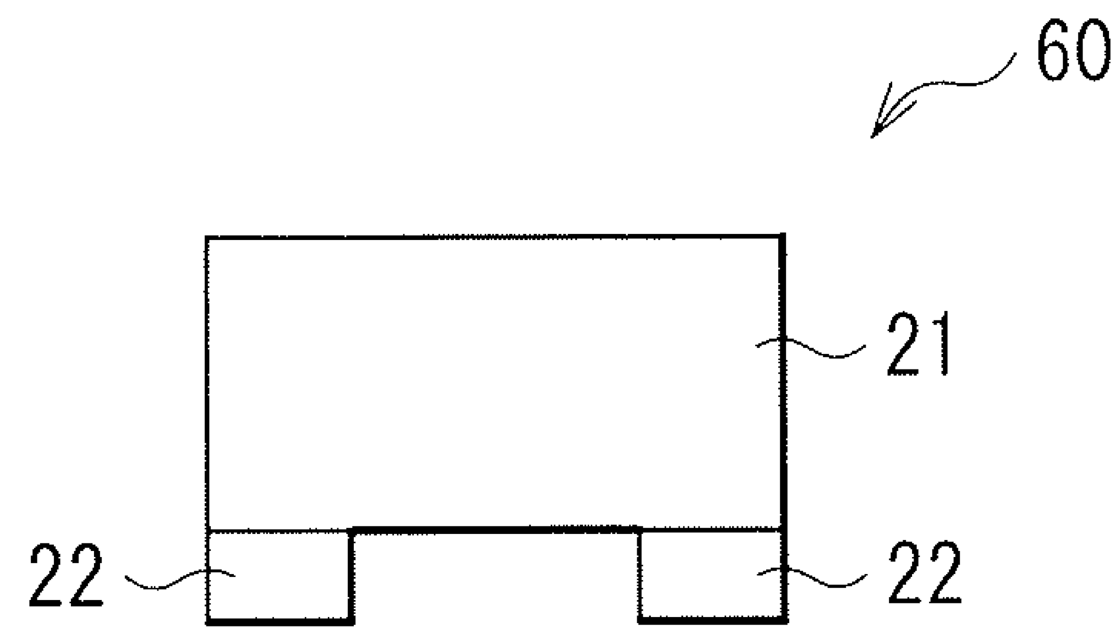
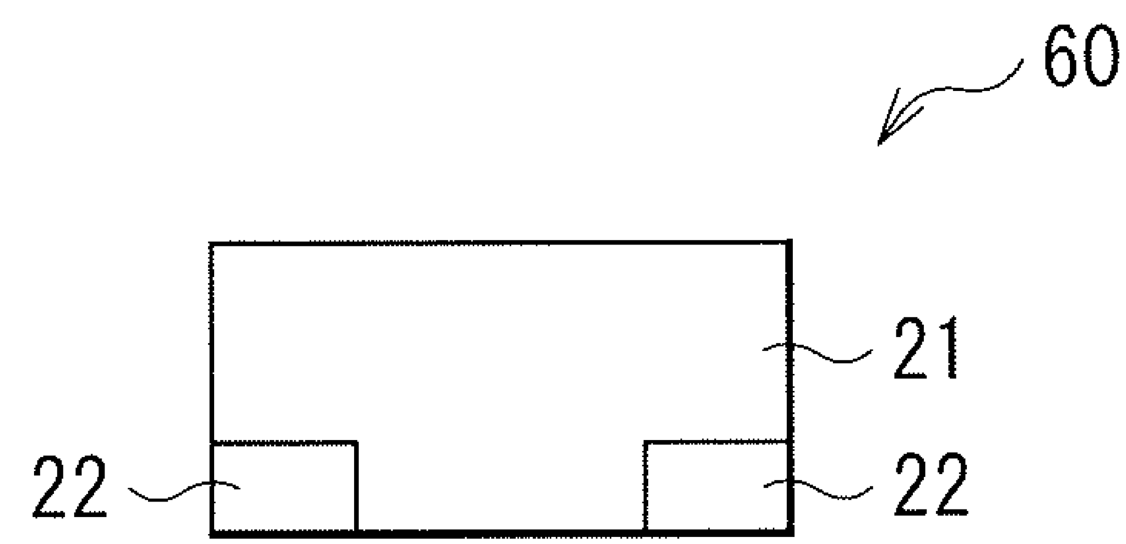


FIG. 35A



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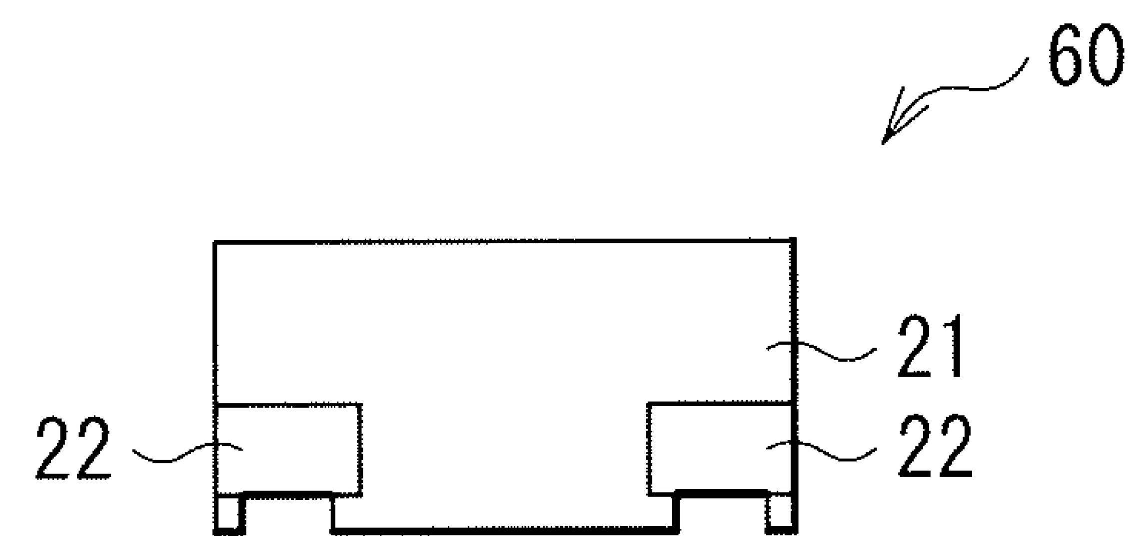
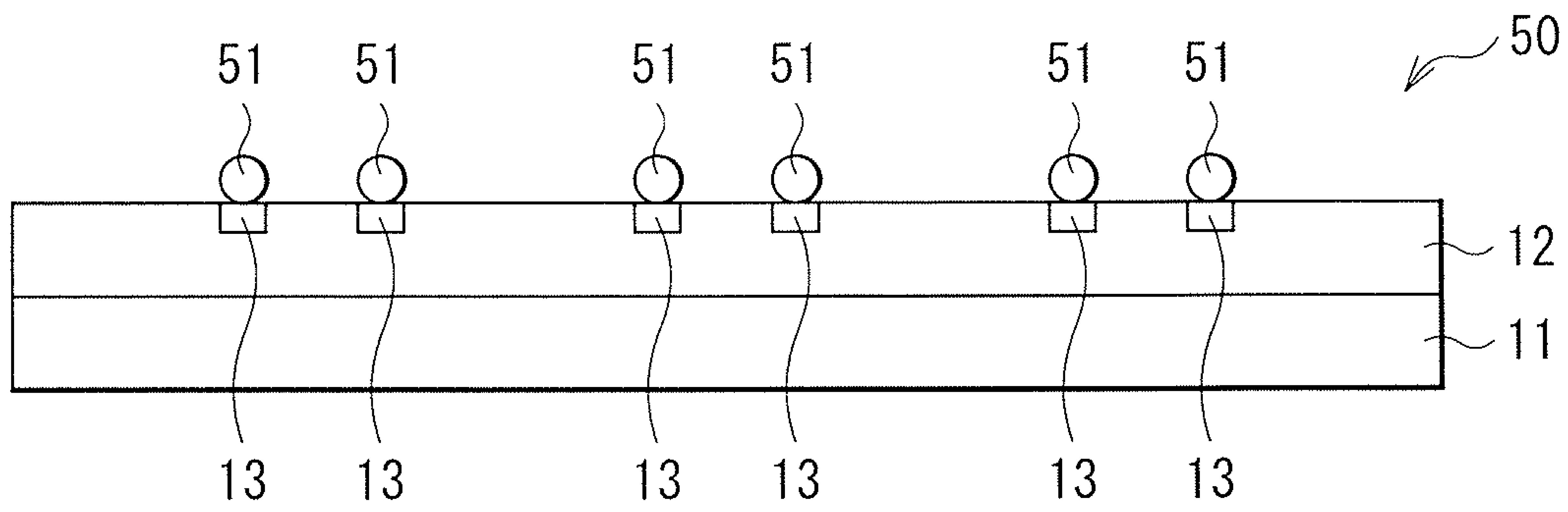


FIG. 35C



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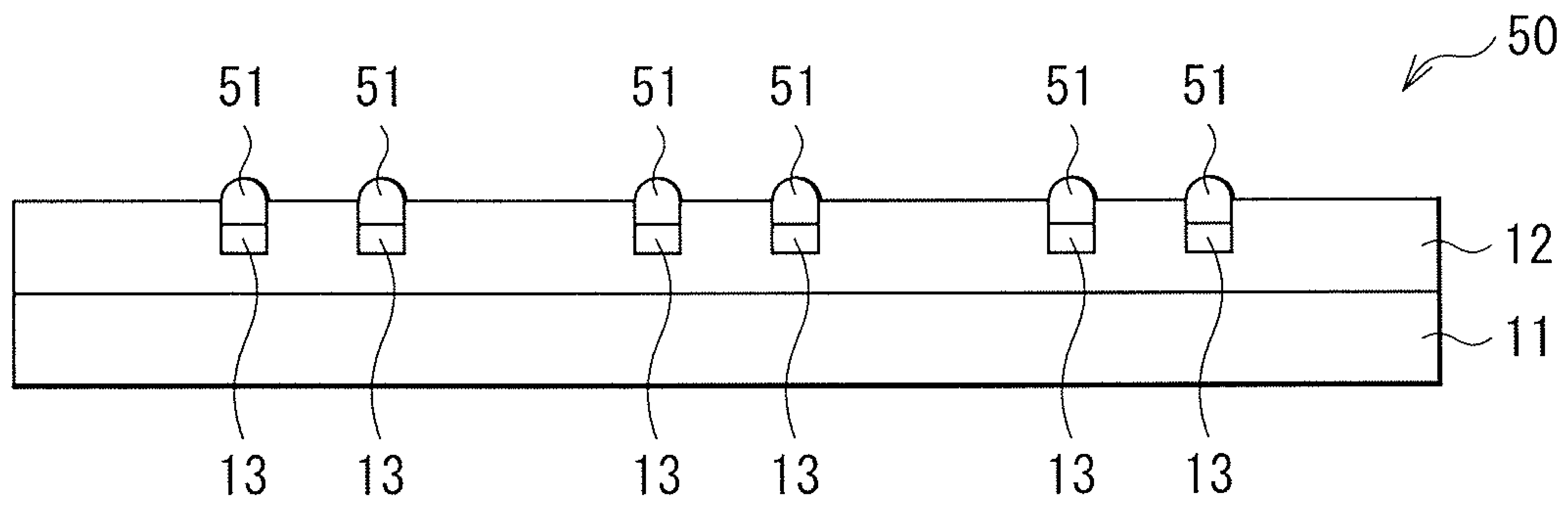

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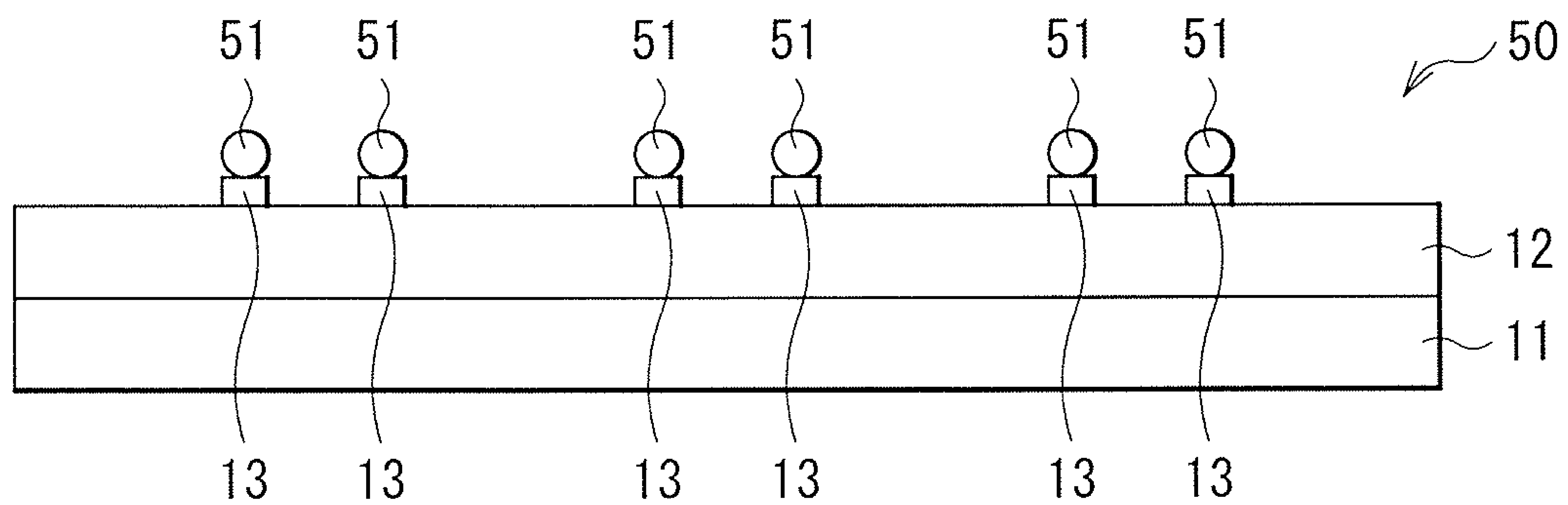

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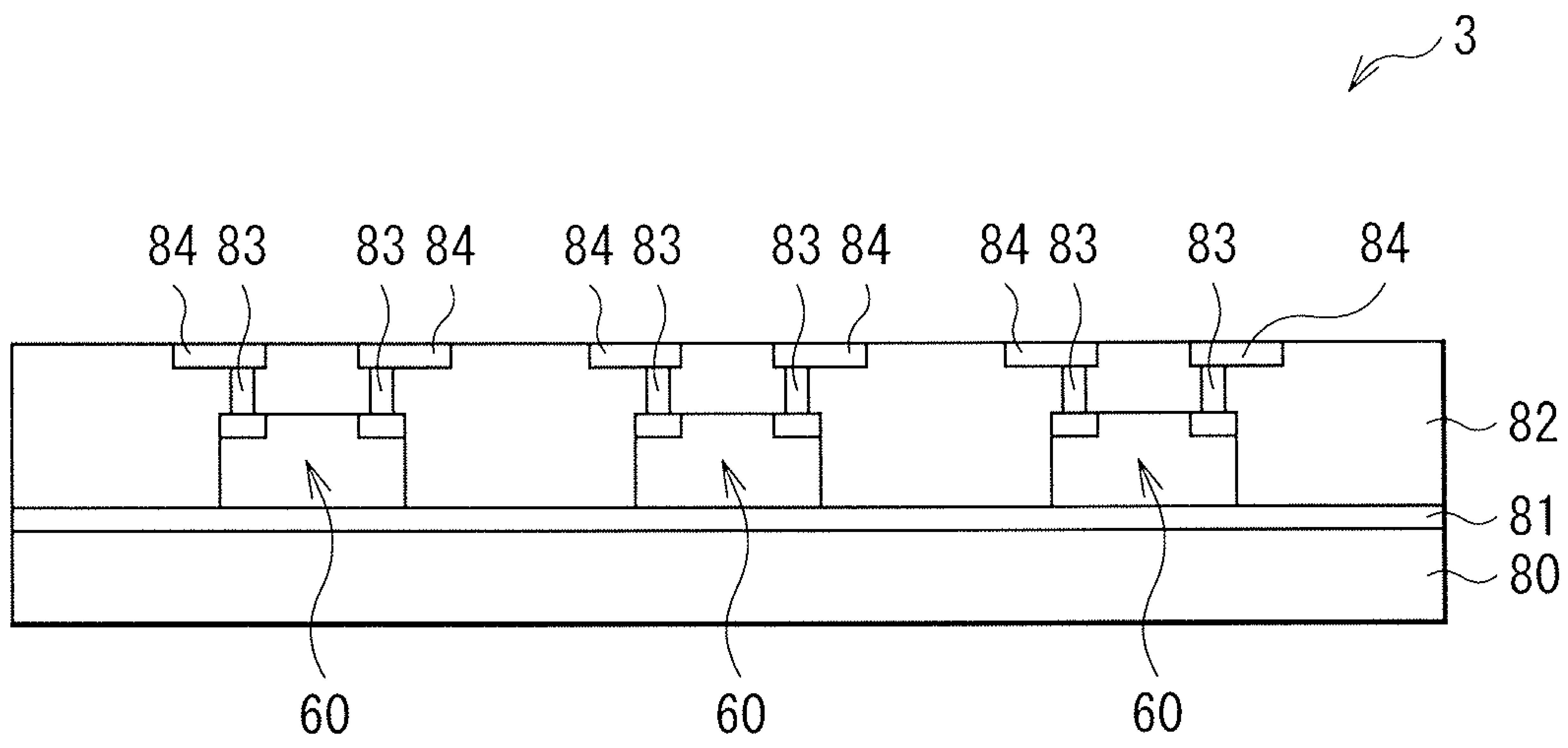

FIG. 37

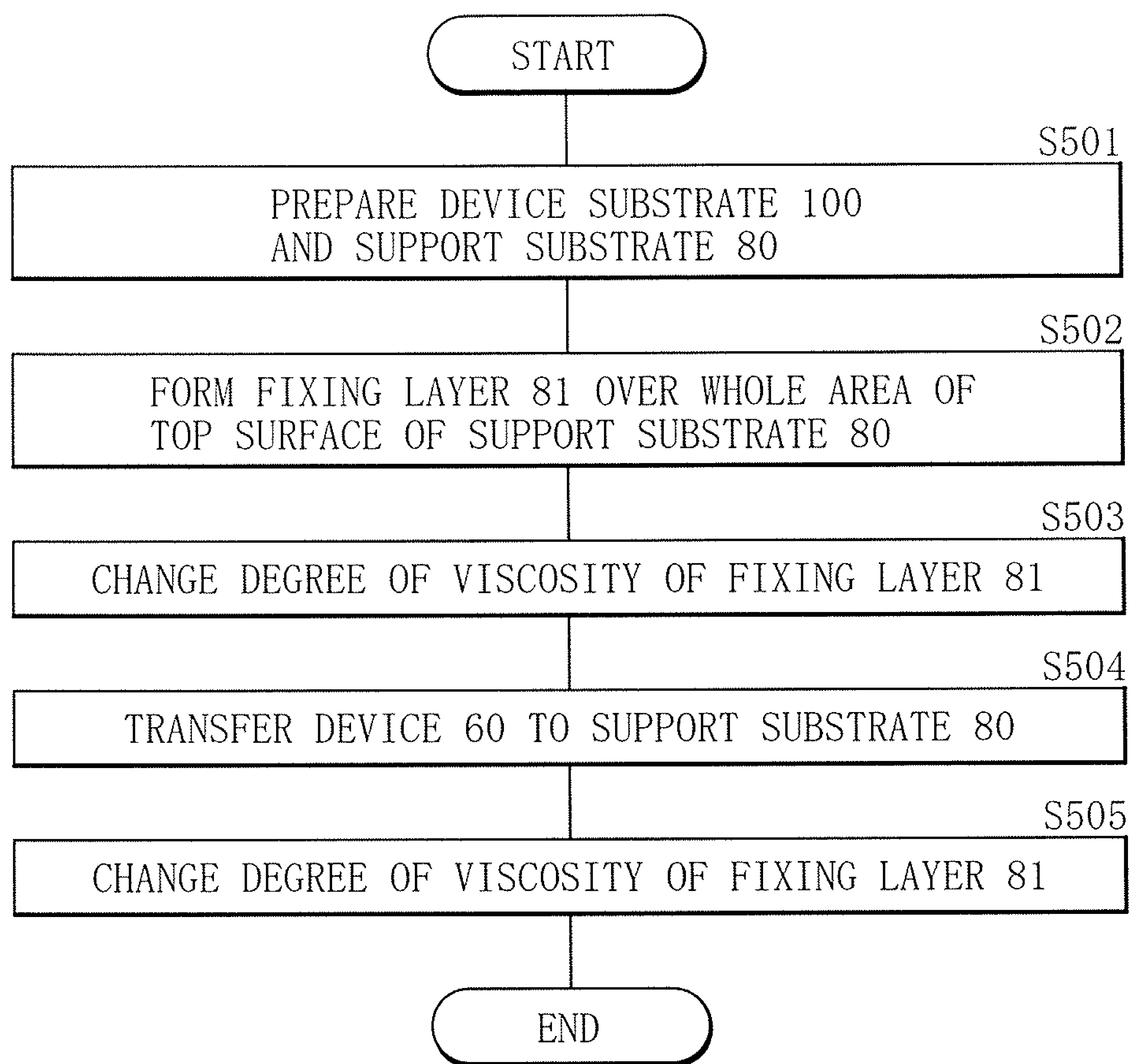

FIG. 38

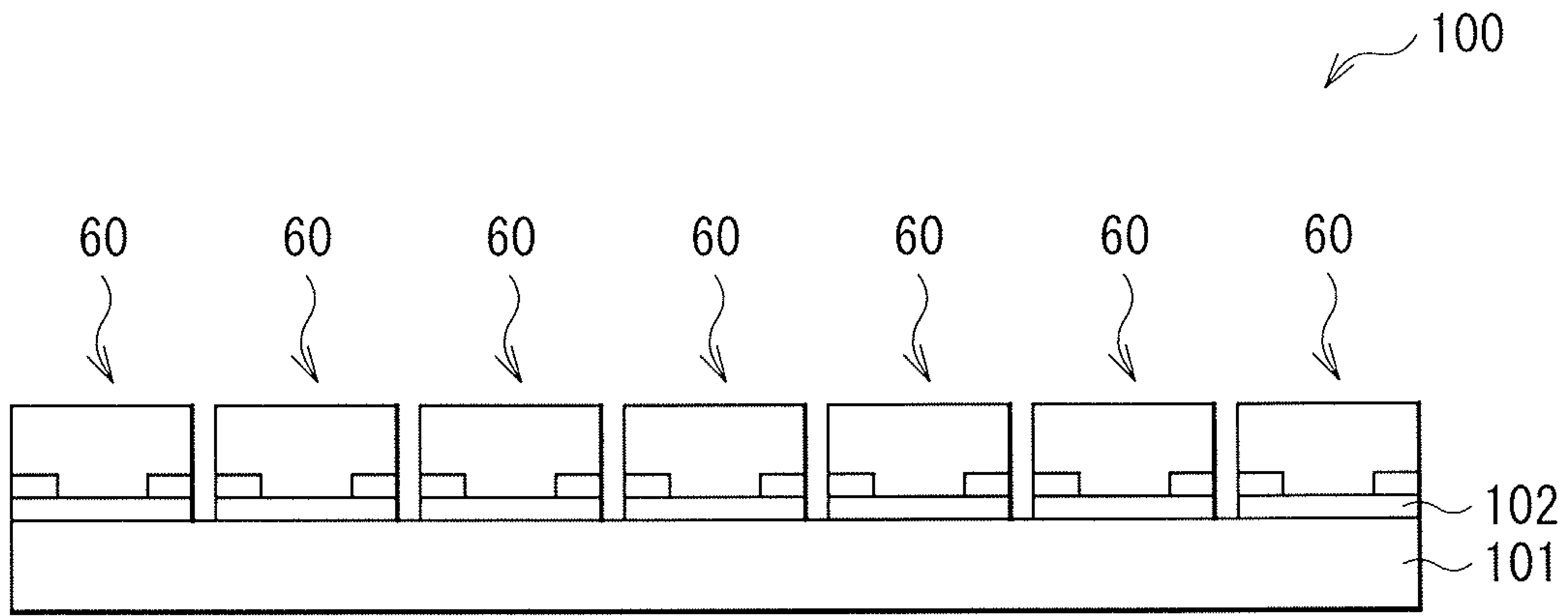

FIG. 39

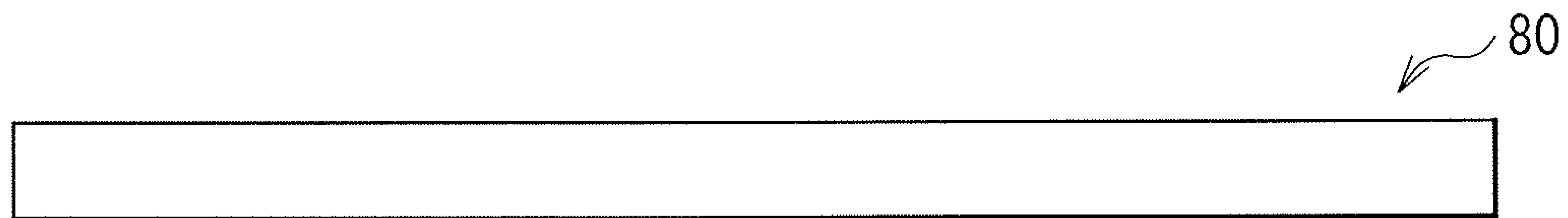

FIG. 40

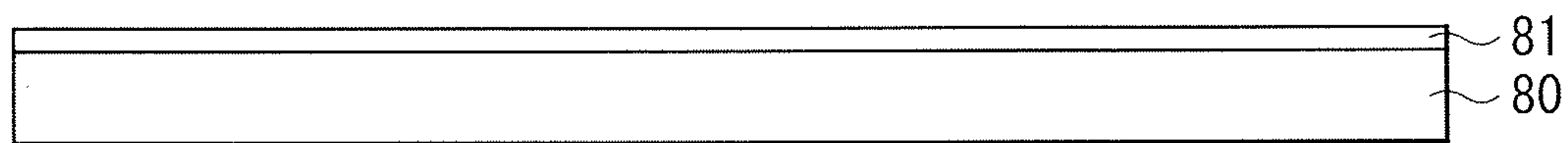

FIG. 41

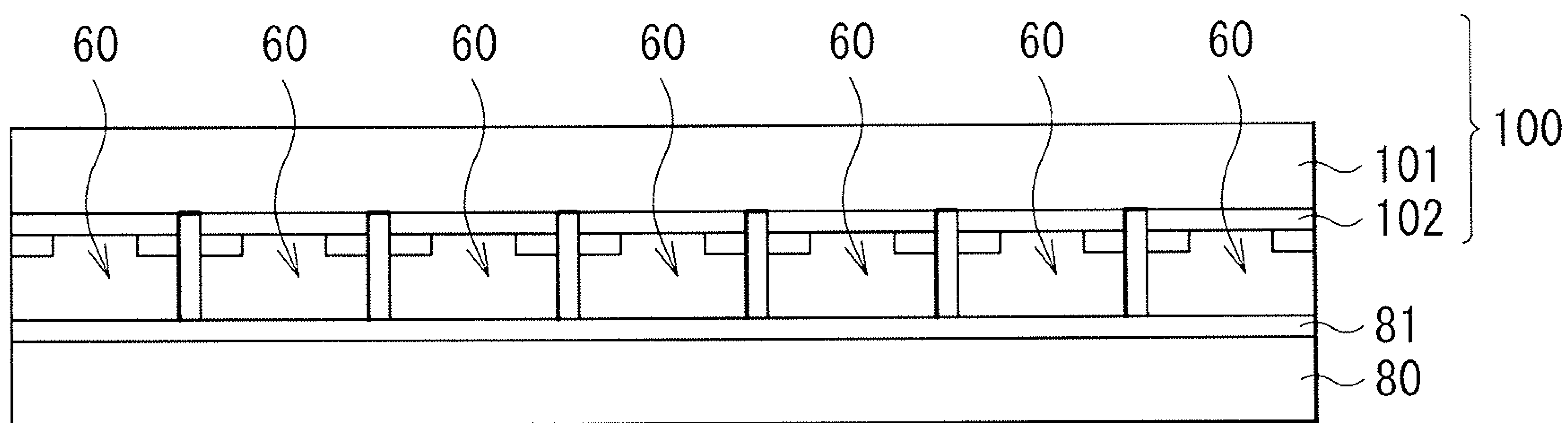

FIG. 42

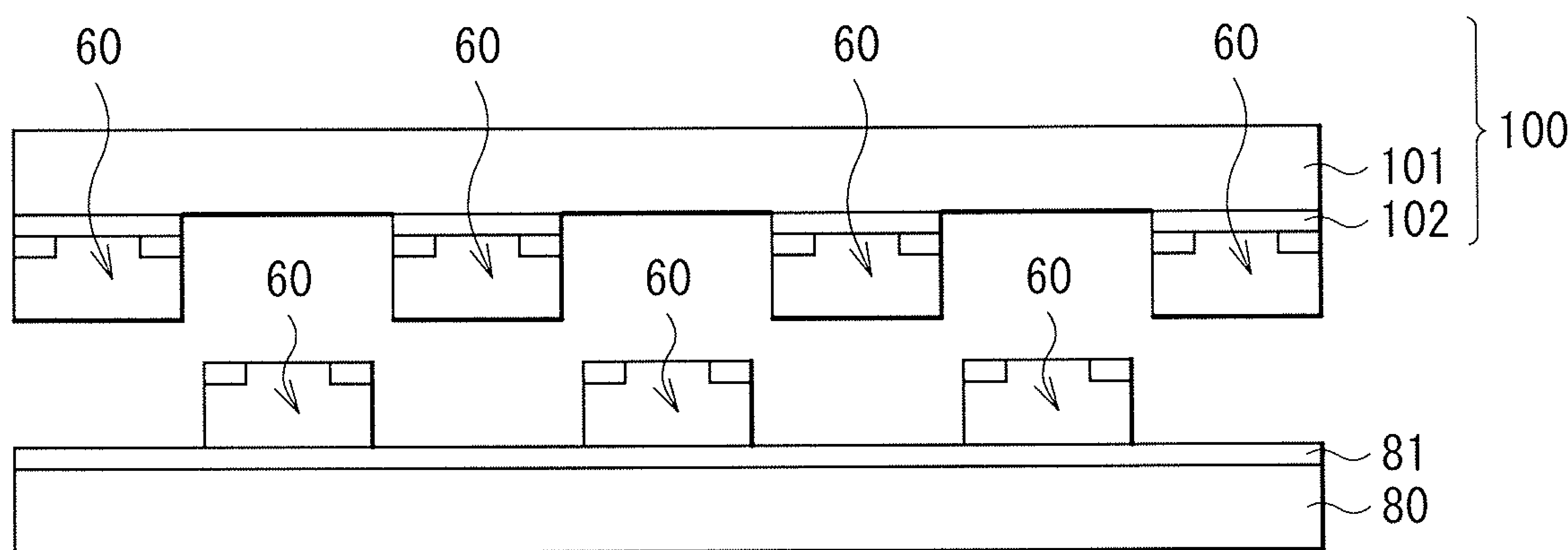

FIG. 43

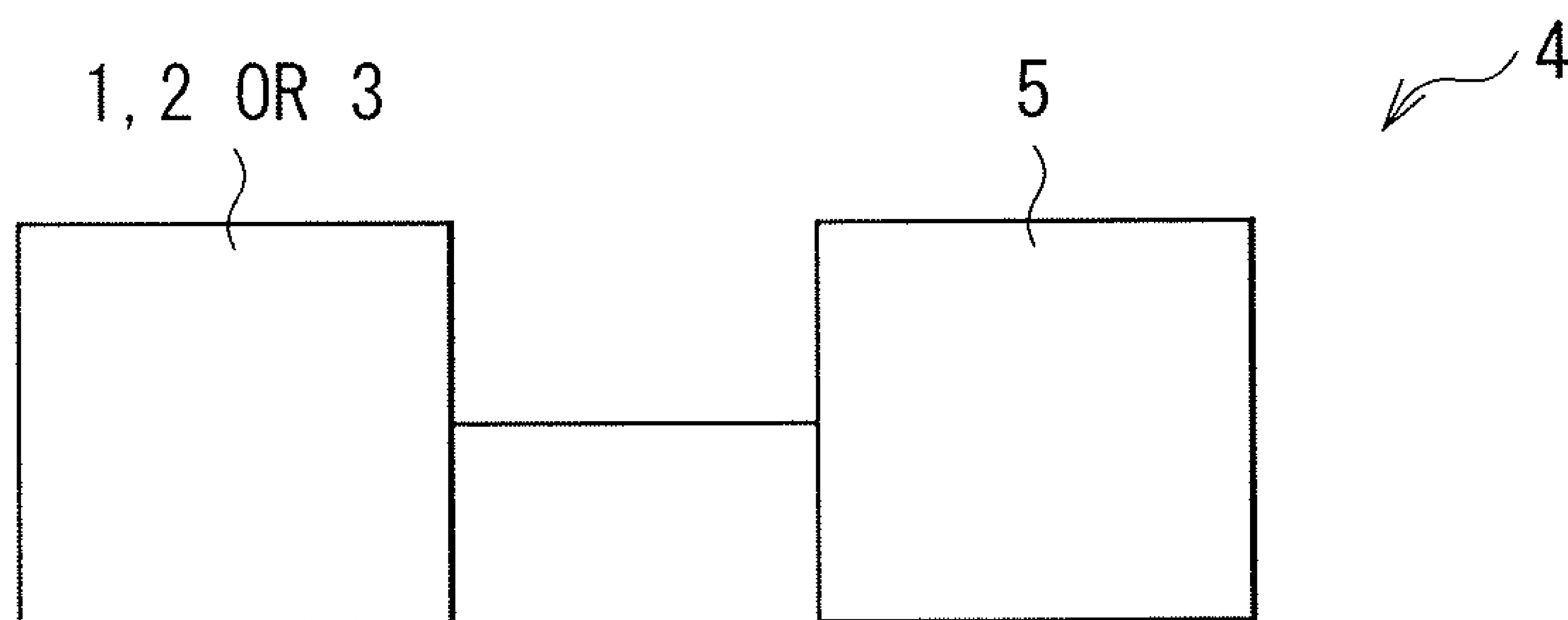

FIG. 44

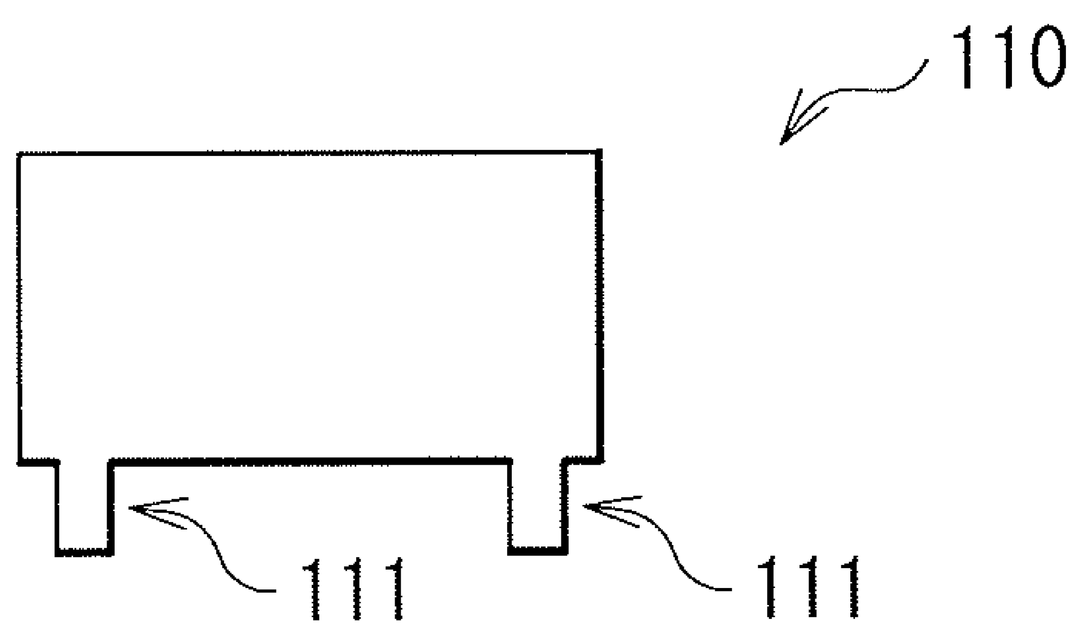

FIG. 45

METHOD OF MANUFACTURING MOUNTING SUBSTRATE AND METHOD OF MANUFACTURING ELECTRONIC APPARATUS

CROSS REFERENCES TO RELATED APPLICATIONS

The present application claims priority to Japanese Priority Patent Application JP 2013-104225 filed in the Japan Patent Office on May 16, 2013, the entire content of which is hereby incorporated by reference.

BACKGROUND

The present application relates to a method of manufacturing a mounting substrate that mounts a device on a substrate by the use of a transfer technique, and a method of manufacturing an electronic apparatus that includes such a mounting substrate.

One of technologies for mounting a lightweight and thin or fine device is a transfer technique. In a case where a device is transferred on a substrate utilizing such a transfer technique, when an electrical connection is made between the transferred device and wiring, it is necessary to form a wiring layer after the device is transferred. In this case, for example, the wiring layer may be formed in such a manner that a device is beforehand reduced in thickness to reduce unevenness of a surface that may be caused by a thickness of the device, or the wiring layer may be formed in such a manner that a vacant space between the devices is beforehand buried to flatten a surface on which the wiring layer is formed (see Japanese Unexamined Patent Application Publication Nos. H10-090688, 2004-219964, and 2006-156455).

SUMMARY

When the transfer technique is used, as described above, it is necessary to form a wiring layer after a device is transferred. As a result, this has posed an issue of involving a lot of processes after a transfer process is completed.

It is desirable to provide a method of manufacturing a mounting substrate and a method of manufacturing an electronic apparatus that allow processes in case of use of the transfer technique to be simplified.

According to an embodiment of the present application, there is provided a method of manufacturing a mounting substrate that includes following two procedures.

(A1) Transferring part or all of a plurality of devices on a device substrate onto a wiring substrate, and temporarily fixing the transferred devices to the wiring substrate with use of a fixing layer having viscosity, the device substrate including a support substrate and the plurality of devices fixed on the support substrate

(A2) Performing a reflow process on the wiring substrate to electrically connect the transferred devices with the wiring substrate, and thereby forming the mounting substrate

According to an embodiment of the present application, there is provided a method of manufacturing an electronic apparatus that is a method of manufacturing an electronic apparatus provided with a mounting substrate, and that includes following three procedures.

(B1) Transferring part or all of a plurality of devices on a device substrate onto a wiring substrate, and temporarily fixing the transferred devices to the wiring substrate with use of a fixing layer having viscosity, the device substrate including a support substrate and the plurality of devices fixed on the support substrate

(B2) Performing a reflow process on the wiring substrate to electrically connect the transferred devices with the wiring substrate, and thereby forming the mounting substrate

(B3) Electrically connecting the mounting substrate with a control section, and thereby forming an electronic apparatus

In the method of manufacturing a mounting substrate and the method of manufacturing an electronic apparatus according to the above-described respective embodiments of the present application, an electrical connection between the transferred device and the wiring substrate is made by performing the reflow process on the wiring substrate in a state where the transferred device is temporarily fixed to the wiring substrate with the use of the fixing layer having viscosity. This makes it possible to omit a step of burying a vacant space between the devices to flatten a surface on which the wiring layer is formed, or a step of forming the wiring layer to make the electrical connection between the device and the wiring.

According to the method of manufacturing a mounting substrate and the method of manufacturing an electronic apparatus of the above-described respective embodiments of the present application, an electrical connection between the transferred device and the wiring substrate is made by performing the reflow process on the wiring substrate in a state where the transferred device is temporarily fixed to the wiring substrate with the use of the fixing layer having viscosity. Therefore, it is possible to simplify processes in case of using the transfer technique.

It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the technology as claimed.

Additional features and advantages are described herein, and will be apparent from the following Detailed Description and the figures.

BRIEF DESCRIPTION OF THE FIGURES

The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments and, together with the specification, serve to explain the principles of the present application.

FIG. **1** is a cross-sectional view showing an example of a configuration of a mounting substrate according to a first embodiment of the present application.

FIG. **2** is a top view showing an example of a configuration of the mounting substrate illustrated in FIG. **1**.

FIG. **3** is a flowchart showing an example of a manufacturing process of the mounting substrate illustrated in FIG. **1**.

FIG. **4** is a cross-sectional view showing an example of a configuration of a device substrate.

FIG. **5** is a cross-sectional view showing an example of a configuration of a wiring substrate.

FIG. **6** is a cross-sectional view showing a process following on the process shown in FIG. **5**.

FIG. **7** is a cross-sectional view showing a process following on the process shown in FIG. **6**.

FIG. **8** is a cross-sectional view showing a process following on the process shown in FIG. **7**.

FIG. 9 is a cross-sectional view showing a process following on the process shown in FIG. 8.

FIG. 10 is a cross-sectional view showing a process following on the process shown in FIG. 9.

FIG. 11 is a flowchart showing another example of the manufacturing process of the mounting substrate illustrated in FIG. 1.

FIG. 12 is a cross-sectional view showing a process following on the process shown in FIG. 4.

FIG. 13 is a cross-sectional view showing a process following on the process shown in FIG. 12.

FIG. 14 is a cross-sectional view showing a process following on the process shown in FIG. 13.

FIG. 15 is a cross-sectional view showing a process following on the process shown in FIG. 14.

FIG. 16 is a cross-sectional view showing a process following on the process shown in FIG. 15.

FIG. 17A is a cross-sectional view showing a modification example of the device illustrated in FIG. 1.

FIG. 17B is a cross-sectional view showing a modification example of the device illustrated in FIG. 1.

FIG. 17C is a cross-sectional view showing a modification example of the device illustrated in FIG. 1.

FIG. 18A is a cross-sectional view showing a modification example of the wiring substrate illustrated in FIG. 1.

FIG. 18B is a cross-sectional view showing a modification example of the wiring substrate illustrated in FIG. 1.

FIG. 18C is a cross-sectional view showing a modification example of the wiring substrate illustrated in FIG. 1.

FIG. 19 is a cross-sectional view showing an example of a configuration of a mounting substrate according to a second embodiment of the present application.

FIG. 20 is a top view showing an example of a configuration of the mounting substrate illustrated in FIG. 19.

FIG. 21 is a flowchart showing an example of a manufacturing process of the mounting substrate illustrated in FIG. 19.

FIG. 22 is a cross-sectional view showing an example of a configuration of a device substrate.

FIG. 23 is a cross-sectional view showing an example of a configuration of a wiring substrate.

FIG. 24 is a cross-sectional view showing a process following on the process shown in FIG. 23.

FIG. 25 is a cross-sectional view showing a process following on the process shown in FIG. 24.

FIG. 26 is a cross-sectional view showing a process following on the process shown in FIG. 25.

FIG. 27 is a cross-sectional view showing a process following on the process shown in FIG. 26.

FIG. 28 is a cross-sectional view showing a process following on the process shown in FIG. 27.

FIG. 29 is a flowchart showing another example of the manufacturing process of the mounting substrate illustrated in FIG. 19.

FIG. 30 is a cross-sectional view showing a process following on the process shown in FIG. 24.

FIG. 31 is a cross-sectional view showing a process following on the process shown in FIG. 30.

FIG. 32 is a cross-sectional view showing a process following on the process shown in FIG. 31.

FIG. 33 is a cross-sectional view showing a process following on the process shown in FIG. 32.

FIG. 34 is a cross-sectional view showing a process following on the process shown in FIG. 33.

FIG. 35A is a cross-sectional view showing a modification example of the device illustrated in FIG. 19.

FIG. 35B is a cross-sectional view showing a modification example of the device illustrated in FIG. 19.

FIG. 35C is a cross-sectional view showing a modification example of the device illustrated in FIG. 19.

FIG. 36A is a cross-sectional view showing a modification example of the wiring substrate illustrated in FIG. 19.

FIG. 36B is a cross-sectional view showing a modification example of the wiring substrate illustrated in FIG. 19.

FIG. 36C is a cross-sectional view showing a modification example of the wiring substrate illustrated in FIG. 19.

FIG. 37 is a cross-sectional view showing an example of a configuration of a mounting substrate according to a third embodiment of the present application.

FIG. 38 is a flowchart showing an example of a manufacturing process of the mounting substrate illustrated in FIG. 37.

FIG. 39 is a cross-sectional view showing an example of a configuration of a device substrate.

FIG. 40 is a cross-sectional view showing an example of a configuration of a wiring substrate.

FIG. 41 is a cross-sectional view showing a process following on the process shown in FIG. 40.

FIG. 42 is a cross-sectional view showing a process following on the process shown in FIG. 41.

FIG. 43 is a cross-sectional view showing a process following on the process shown in FIG. 42.

FIG. 44 is a schematic diagram showing an example of a configuration of an electronic apparatus according to a fourth embodiment of the present application.

FIG. 45 is a cross-sectional view showing an example of a chip-shaped material.

DETAILED DESCRIPTION

Hereinafter, some embodiments of the present application are described in details with reference to the drawings. It is to be noted that the descriptions are provided in the order given below.

1. First Embodiment (Mounting Substrate)

An example where a device includes a bump, and a fixing layer is provided on a wiring substrate side

2. Modification Example of First Embodiment (Mounting Substrate)

An example where a device includes a bump, and a fixing layer is provided on a device substrate side

A variation of an electrical connection part

3. Second Embodiment (Mounting Substrate)

An example where a wiring substrate includes a bump, and a fixing layer is provided on a device substrate side

4. Modification Example of Second Embodiment (Mounting Substrate)

An example where a wiring substrate includes a bump, and a fixing layer is provided on a wiring substrate side

A variation of an electrical connection part

5. Third Embodiment (Mounting Substrate)

An example where a device and a support substrate include no bump, and a fixing layer is provided on a support substrate side

6. Fourth Embodiment (Electronic Apparatus)

1. First Embodiment

Configuration

First, description is provided on a mounting substrate 1 according to a first embodiment of the present application. FIG. 1 shows an example of a cross-sectional configuration

of the mounting substrate **1**. FIG. **2** shows an example of a top surface configuration of the mounting substrate **1**. FIG. **1** corresponds to a cross-sectional configuration in the direction shown with an arrow A-A in FIG. **2**. The mounting substrate **1** is a substrate where a plurality of devices **20** are mounted on a wiring substrate **10**. The wiring substrate **10** and each of the devices **20** are electrically connected with each other.

The wiring substrate **10** may include, for example, a support substrate **11**, an insulating layer **12**, and a metallic layer **13**. Also, the wiring substrate **10** may include, for example, a plurality of wires that are electrically connected with one or more metallic layers **13** in the insulating layer **12**. The support substrate **11** supports the plurality of devices **20**, and may be configured of, for example, a silicon substrate, a glass substrate, a resin substrate, and/or the like. The insulating layer **12** is a layer for insulating the plurality of above-described wires from one another, and serves as an interlayer insulating film. The insulating layer **12** may be configured of, for example, an insulating inorganic material such as SiO_2. The top surface of the insulating layer **12** has a role as a mounting surface on which each of the devices **20** is mounted. A wiring layer is formed of the insulating layer **12** and the plurality of above-described wires.

The metallic layer **13** electrically connects the device **20** with the above-described wires, and is electrically connected with the above-described wires in the insulating layer **12**. The metallic layer **13** may be configured to include, for example, UBM (Under Bump Metal) that serves as a foundation for a solder bump. The UBM may be configured of a material such as Ni, and serves as a solder diffusion suppression layer. In the metallic layer **13**, for example, the side surface thereof may be buried in the insulating layer **12**, and the top surface thereof may be exposed. The metallic layer **13** is arranged in such a manner that, for example, the top surface of the metallic layer **13** may be in the same plane as the top surface of the insulating layer **12**. It is to be noted that it is not necessary that all of the metallic layers **13** be electrically connected with the wires in the insulating layer **12**. For example, some metallic layers **13** out of the plurality of metallic layers **13** that are provided in correspondence with the respective devices **20** may be those that are joined with metallic protrusions that are provided on the respective devices **20** to assure the stability of the devices **20**.

As detailed hereinafter, each of the devices **20** on the wiring substrate **10** is transferred on the wiring substrate **10** from a device substrate **30** using a transfer technique. The respective devices **20** are arranged to be away from one another in a plane. The device **20** may be, for example, a submillimeter-sized chip. It is to be noted that the device **20** may be larger in size than a submillimeter size. The device **20** is an individual component in a chip-shaped form to be used as a constituent part for an apparatus or an electronic circuit. Examples of the device **20** may include a light-emitting device (such as an LED (Light-Emitting Diode), an LD (Laser Diode), an organic EL), a light receiving device (such as a photodiode, a photodetector, a CCD (Charge-Coupled Device), and a CMOS (Complementary Metal-Oxide Semiconductor)), and a circuit device (such as a capacitor, a transistor, a resistor, an IC (Integrated Circuit), and an LSI (Large-Scale Integrated Circuit)). Alternatively, the device **20** may be a device that includes at least two out of the above-described light-emitting devices, light receiving devices, and circuit devices, for example.

For example, as shown in FIG. **1**, the device **20** may have a function section **21**, and a metallic layer **22** and a solder bump **23** that are provided on the undersurface of the function section **21**. The function section **21** is a part having the functions of the device **20** that is exemplified in the above, and may be configured to include, for example, an LED, an LD, an organic EL, a photodiode, a photodetector, a CCD, a CMOS, a capacitor, a transistor, a resistor, an IC, an LSI, and/or the like. The metallic layer **22** makes a connection between the function section **21** and the metallic layer **13** via the solder bumps **23**, and is electrically or capacitively connected with the function section **21**. It is to be noted that, when each of the devices **20** is provided with the plurality of metallic layers **22**, a part of these metallic layers **22** may be a dummy that is not useful for the functions of the function section **21**. In this case, a portion that is configured of the dummy metallic layer **13** and the solder bump **23** that is provided on such a dummy metallic layer **13** serves as a metallic protrusion that is provided on the device **20** to assure the stability of the device **20**.

The metallic layer **22** and the solder bump **23** are laminated in this order on the undersurface of the function section **21**. The metallic layer **22** and the solder bump **23** are projecting toward the wiring substrate **10** side on the undersurface of the function section **21**, and configure a protrusion standing out from a surrounding area. In other words, each of the devices **20** has an electrically-conductive protrusion that is made up of the metallic layer **22** and the solder bump **23**. For example, as shown in FIG. **1**, the electrically-conductive protrusion may be configured of a block-like metal member. It is to be noted that the conductive protrusion may be alternatively configured of, for example, a wedge-like metal member. Further, it is to be noted that the solder bump **23** may not necessarily be in a spherical shape from the beginning. The solder bump **23** may take a shape such as cylinder, circular cone, inverted circular cone, mushroom form, quadrangular pyramid, quadrangular prism, prismatic column, pyramid, polygonal pyramid, and polygonal column. The solder bump **23** is transformed into an almost spherical shape by surface tension of a solder in a state of being in the form of a liquid with a temperature above the solder melting point.

It is to be noted that FIG. **1** illustrates by an example a case where each of the devices **20** has two electrically-conductive protrusions on the undersurface of the function section **21**. However, each of the devices **20** may have one or three or more electrically-conductive protrusions alternatively. The electrically-conductive protrusion may be, for example, in a shape of a rectangle, square, circle, or ellipse when viewed from a direction of a normal to the undersurface of the function section **21**. The number of the electrically-conductive protrusions may be desirably three or more in consideration of the stability of the device **20**. When the number of the electrically-conductive protrusions is one or two, the electrically-conductive protrusion may be desirably in a shape of a rectangle or ellipse in consideration of the stability of the device **20**.

The metallic layer **22** may be configured to include the UBM, for example. In the metallic layer **22**, for example, a part of the side surfaces thereof may be exposed from the function section **21**, and the undersurface thereof may be exposed. The solder bump **23** may be configured of, for example, alloy containing lead or tin as a primary component, and may be formed in a manner of, for example, electrolytic plating, imprinting of a solder paste, and/or the like.

[Manufacturing Method]

Next, the description is provided on an example of a method of manufacturing the mounting substrate **1**.

FIG. **3** shows an example of a manufacturing process for the mounting substrate **1** using a flowchart. Each of FIG. **4** to FIG. **10** shows an example of a manufacturing process for the mounting substrate **1** using a cross-sectional view. First, the device substrate **30** and the wiring substrate **10** are prepared (step S**101**, FIG. **4** and FIG. **5**).

For example, as shown in FIG. **4**, the device substrate **30** may have a support substrate **31**, a fixing layer **32**, and the plurality of devices **20**. Each of the devices **20** is arranged on the support substrate **31** with the metallic layer **22** directed upward (that is, with the metallic layer **22** directed toward the opposite side, of the function section **21**, from the support substrate **31**). The support substrate **31** supports the plurality of devices **20**, and may be configured of, for example, a silicon substrate, a glass substrate, a resin substrate, and/or the like. The fixing layer **32** fixes each of the devices **20** on the support substrate **31**, and peels off each of the devices **20** from the support substrate **31** at the time of a transfer process. When a transfer is carried out by a laser ablation method, the fixing layer **32** may be configured of, for example, a material that absorbs light at laser oscillation wavelength band. The fixing layer **32** may be formed, for example, over a whole area of the top surface of the support substrate **31**. For example, as shown in FIG. **4**, the fixing layer **32** may be formed only at a gap between the support substrate **31** and each of the devices **20**. Considering the transfer performance, as shown in FIG. **4**, the fixing layer **32** may be preferably formed for each of the devices **20**. Further, considering the simplicity of the process, the fixing layer **32** may be preferably formed over a whole area of the top surface of the support substrate **31**. The fixing layer **32** may come in direct contact with the support substrate **31**. It is to be noted that an adhesion layer, an insulating layer, a metallic layer, and/or the like may be interposed between the fixing layer **32** and the support substrate **31**.

Next, a fixing layer **41** is formed over a whole area of the top surface of the wiring substrate **10** (step S**102**, FIG. **6**). The fixing layer **41** accepts each of the devices **20** at the time of a transfer process, and holds one or more of the transferred devices **20** using an adhesive force. The fixing layer **41** is in the form of a liquid having viscosity or a gel, and may be configured of, for example, a flux. The flux is mainly made of resin and solvent. The flux is a so-called solder flux, and is a material in the form of a liquid or a paste that has a function of reducing oxides on the metal surface or includes an activator to have a reduction action. The above-described activator may be molten salt, acid, or the like having the reducing characteristics. The above-described molten salt may be a halide, such as chloride and fluoride. Examples of the above-described acid may include orthophosphoric acid, organic acid, amines, hydrohalic acid amine salt, and the like. In some instances, any other additive agent may be added to the flux as appropriate.

By the use of a method such as spin coating, spray method, doctor blade method, printing, transfer method, and imprinting method, the flux is coated with a small and uniform thickness over a whole area of the top surface of the wiring substrate **10**. Therefore, at this time, the flux has a low degree of viscosity suitable for coating.

Subsequently, the degree of the viscosity of the fixing layer **41** on the wiring substrate **10** is changed (step S**103**). For example, using at least one method of heating, decompression, light irradiation, and addition of curing agent, a process is carried out that raises the degree of the viscosity of the flux applied on the top surface of the wiring substrate **10**. The degree of the viscosity of the fixing layer **41** is changed after the fixing layer **41** is formed on the top surface of the wiring substrate **10** and before a transfer process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **41** when the fixing layer **41** is applied on the top surface of the wiring substrate **10** is different from that when the fixing layer **41** accepts each of the devices **20** at the time of the transfer process. More specifically, when the fixing layer **41** is formed on the top surface of the wiring substrate **10**, the degree of the viscosity of the fixing layer **41** may be preferably relatively low, and may be preferably relatively high at the time of the transfer process.

When heating is used for changing the degree of viscosity, a solvent contained in the flux is volatized by heating the wiring substrate **10** using, for example, a hot plate, an atmosphere furnace, an infrared heating furnace, and/or the like to change the viscosity of the flux. When a decompression furnace is used for changing the viscosity, the wiring substrate **10** coated with the flux is placed in the decompression furnace to be in a decompression state slowly. This volatizes the solvent contained in the flux to change the degree of the viscosity of the flux. In a case where the light irradiation is used for changing the degree of the viscosity, and when photosensitive resin is used as resin to be contained in the flux, the photosensitive resin is modified in composition in such a manner that the flux is irradiated with optical energy rays such as ultraviolet rays, to change the degree of the viscosity of the flux. When a curing agent is used for changing the degree of the viscosity, the curing agent having a curing function is sprayed onto the flux applied on the top surface of the wiring substrate **10** to change the degree of the viscosity of the flux.

Thereafter, part or all of the plurality of devices **20** on the device substrate **30** are transferred on the wiring substrate **10** (step S**104**). First, the device substrate **30** and the wiring substrate **10** are attached to a transfer apparatus. Next, the device substrate **30** and the wiring substrate **10** are arranged in opposition to each other with a predetermined vacant space **42** interposed between (that is, with them placed away from each other) (FIG. **7**) or with them closely-attached to each other (FIG. **8**). Subsequently, one or more of the plurality of devices **20** on the device substrate **30** are transferred on the wiring substrate **10** using, for example, a laser ablation method (FIG. **9**). This temporarily fixes the transferred device(s) **20** (or solder bumps **23**) on the wiring substrate **10** with the use of the fixing layer **41**. It is to be noted that such a transfer process may be carried out in a method other than the laser ablation.

At the time of the transfer process, an electrically-conductive protrusion that is configured of the metallic layer **22** and the solder bump **23** sticks into the fixing layer **41** to serve as an anchor. At this time, a height of the electrically-conductive protrusion that is configured of the metallic layer **22** and the solder bump **23** (to be exact, a distance between the undersurface of the function section **21** and a tip end of the solder bump **23**) may be larger (longer) or smaller (shorter) than a thickness of the fixing layer **41**.

After the transfer process, the whole metallic layer **22** or a part thereof and the metallic layer **13** are opposed to each other with the solder bump **23** in between. Further, when viewed from a direction of a normal to the mounting surface of the wiring substrate **10**, it is enough that a portion where the metallic layer **22** and the metallic layer **13** are opposed to each other has an area at least about a half as large as the area of the metallic layer **22**. Therefore, it is enough that this transfer process has the accuracy that allows such a transfer to be achieved.

Afterward, the degree of the viscosity of the fixing layer **41** on the wiring substrate **10** is changed (step S**105**). For example, by heating (post-baking), a process is carried out that raises the degree of the viscosity of the flux applied on the top surface of the wiring substrate **10**. The degree of the viscosity of the fixing layer **41** is changed after the transfer is completed and before a reflow process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **41** when the fixing layer **41** accepts each of the devices **20** at the time of the transfer process is slightly different from that when the reflow process is performed. More specifically, when the reflow process is carried out, the degree of the viscosity of the fixing layer **41** may be desirably higher than that at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method. It is to be noted that this step is intended to prevent each of the transferred devices **20** from shifting during a period of time before the reflow process is performed or during the reflow process. Therefore, this step may be omitted when there is not concern about such a possibility.

Subsequently, a reflow process is carried out for the wiring substrate **10** (step S**106**, FIG. **10**). At this time, the solder bump **23** is melted or softened, and thus the metallic layer **22** and the metallic layer **13** are opposed to each other or are exactly face to face with each other due to a self-alignment function of the solder bump **23**. Further, an electrical connection between the transferred device **20** (or the metallic layer **22**) and the wiring substrate **10** (or the metallic layer **13**) is made as a consequence of melting or softening of the solder bump **23**. In other words, the transferred device **20** (or the metallic layer **22**) and the wiring substrate **10** (or the metallic layer **13**) are electrically connected with each other via the electrically-conductive protrusion (the solder bump **23**). After the reflow process, the solder bump **23** is solidified, and accordingly, each of the devices **20** is fixed with high accuracy at a predetermined position on the support substrate **11**.

Finally, the fixing layer **41** is removed (cleaned) (step S**107**). Here, it is sufficient that the flux used as the fixing layer **41** is dissolved, and any residual material is eliminated. A cleaning agent suitable for the flux may be used. At this time, it is possible to clear away any material (dirt) attached on the mounting surface of the wiring substrate **10**, such as a residue that may be generated from the laser ablation, in conjunction with the cleaning of the flux. It is to be noted that when the flux is a non-cleaning type, removal of the fixing layer **41** may be omitted.

[Effects]

Next, description is provided on the effects of the method of manufacturing the mounting substrate **1**.

In this embodiment of the present application, the electrical connection between the transferred device **20** and the wiring substrate **10** is made by performing a reflow process on the wiring substrate **10** in a state where the transferred device **20** is temporarily fixed to the wiring substrate **10** with the use of the fixing layer **41**. This makes it possible to omit a step of burying a vacant space between the devices **20** to flatten a surface on which the wiring layer is formed, or a step of forming the wiring layer, in order to make the electrical connection between the device **20** and the wiring. As a result, this allows steps following on the transfer process to be simplified.

Further, as shown in FIG. **7**, when a non-contact transfer (proximity transfer) is carried out, each of the devices **20** remaining on the device substrate **30** without being transferred (hereinafter referred to as a "non-transferred device") does not come in contact with the fixing layer **41**. Therefore, a part of the fixing layer **41** or a residue that may be generated from the laser ablation is not attached to the non-transferred device. Consequently, there is no concern about the possibility of deterioration in the transfer performance of the non-transferred device. In addition, in the proximity transfer, there is no necessity for moving the device substrate **30** up and down before or after the transfer process, which allows the transfer processing time to be shortened. Moreover, in the proximity transfer, the device substrate **30** and the wiring substrate **10** do not come in contact with each other. As a result, when there is slight unevenness on the surface (mounting surface) of the wiring substrate **10**, or there is slight waviness on the device substrate **30** and/or the wiring substrate **10**, it is possible to avoid damage to each of the devices **20** that could be caused by contact transfer.

In addition, as shown in FIG. **10**, when the reflow process is carried out, it is possible to improve the alignment accuracy due to the self-alignment function of a solder. Therefore, there is no necessity for preparing a high-level adjusting apparatus for improving the alignment accuracy during the transfer process. As a result, it is possible to simplify steps during the transfer process, as well as to perform the transfer using inexpensive manufacturing facility. Further, when the electrical connection between the device **20** and the wiring substrate **10** is made using the reflow process, even if a defect in the device **20** is found later, it is possible to take out the defective device **20** with ease. In an existing method in which the device **20** is embedded to form the wiring layer, it is difficult to take out the defective device **20** with ease.

Moreover, in this embodiment of the present application, the degree of the viscosity of the fixing layer **41** is changed after the fixing layer **41** is applied on the top surface of the wiring substrate **10** and before the transfer process is performed. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **20** after the transfer. Further, in this embodiment of the present application, the degree of the viscosity of the fixing layer **41** is changed after the transfer process is performed and before the reflow process is performed. Also, this makes it possible to reduce the possibility that a positional shift will occur in each of the devices **20** immediately before or in the middle of the reflow process.

2. Modification Examples of First Embodiment

Modification Example 1

Next, description is provided on a modification example of the method of manufacturing the mounting substrate **1** according to the above-described embodiment of the present application. FIG. **11** shows another example of the manufacturing process for the mounting substrate **1** using a flowchart. Each of FIG. **12** to FIG. **16** shows another example of the manufacturing process for the mounting substrate **1** using a cross-sectional view. In this modification example, a fixing layer **43** is used instead of the fixing layer **41**. This fixing layer **43** is applied on the device substrate **30**.

First, the device substrate **30** and the wiring substrate **10** are prepared (step S**201**, FIG. **4** and FIG. **5**). Next, the fixing layer **43** is formed on the undersurface of each of the devices **20** (step S**202**, FIG. **12**). In concrete terms, the fixing layer **43** is formed on a top end of the electrically-conductive protrusion that is configured of the metallic layer **22** and the

solder bump **23**. It is to be noted that the fixing layer **43** may be formed only on the undersurface of the device **20** to be transferred among the plurality of devices **20** on the device substrate **30**. The fixing layer **43** accepts each of the devices **20** at the time of the transfer process, while holding one or more of the transferred devices **20** using an adhesive force. More specifically, the fixing layer **43** is a flux. The flux is the same as the flux of the fixing layer **41** that is used in the above-described embodiment of the present application.

For example, by the use of a method such as a dip method, a spray method, and printing, the flux is applied with a small and uniform thickness on the top end of the electrically-conductive protrusion. Therefore, at this time, the flux has a low degree of viscosity suitable for coating.

Subsequently, the degree of the viscosity of the fixing layer **43** on the device substrate **30** is changed (step S**203**). For example, using at least one method of heating, decompression, light irradiation, and addition of curing agent, a process is carried out that raises the degree of the viscosity of the flux applied on the top surface of the device substrate **30**. The degree of the viscosity of the fixing layer **43** is changed after the fixing layer **43** is formed on the device substrate **30** and before the transfer process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **43** when the fixing layer **43** is applied on the device substrate **30** is different from that when the fixing layer **43** accepts each of the devices **20** at the time of the transfer process. More specifically, when the fixing layer **43** is formed on the device substrate **30**, the degree of the viscosity of the fixing layer **43** may be preferably relatively low, and may be preferably relatively high at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method. It is to be noted that, in an embodiment where the optimum degree of viscosity desired for the fixing layer **43** when the fixing layer **43** is applied on the device substrate **30** is not significantly different from that when the fixing layer **43** accepts each of the devices **20** at the time of the transfer process, when the fixing layer **43** is applied on the device substrate **30**, this step may be omitted.

Thereafter, part or all of the plurality of devices **20** on the device substrate **30** are transferred on the wiring substrate **10** (step S**204**). First, the device substrate **30** and the wiring substrate **10** are attached to a transfer apparatus. Next, the device substrate **30** and the wiring substrate **10** are arranged in opposition to each other with a predetermined vacant space **42** interposed between (that is, with them placed away from each other) (FIG. **13**) or with them closely-attached to each other (FIG. **14**). Subsequently, one or more of the plurality of devices **20** on the device substrate **30** are transferred on the wiring substrate **10** using, for example, a laser ablation method (FIG. **15**). This temporarily fixes the transferred device(s) **20** (or the solder bump(s) **23**) on the wiring substrate **10** with the use of the fixing layer **43**. It is to be noted that such a transfer process may be carried out in a method other than the laser ablation.

At the time of the transfer process, an electrically-conductive protrusion that is configured of the metallic layer **22** and the solder bump **23** sticks into the fixing layer **43** to function as an anchor. At this time, it is important that a height of the electrically-conductive protrusion that is configured of the metallic layer **22** and the solder bump **23** (to be exact, a distance between the undersurface of the function section **21** and a tip end of the solder bump **23**) is larger (longer) than a thickness of the fixing layer **43**, in terms of an anchor effect.

After the transfer process, the whole metallic layer **22** or a part thereof and the metallic layer **13** are opposed to each other with the solder bump **23** in between. Further, when viewed from a direction of a normal to the mounting surface of the wiring substrate **10**, it is enough that a portion where the metallic layer **22** and the metallic layer **13** are opposed to each other has an area at least about a half as large as the area of the metallic layer **22**. Therefore, it is enough that this transfer process has the accuracy that allows such a transfer to be achieved.

Afterward, the degree of the viscosity of the fixing layer **43** on the wiring substrate **10** is changed (step S**205**). For example, by heating (post-baking), a process is carried out that raises the degree of the viscosity of the flux on the wiring substrate **10**. The degree of the viscosity of the fixing layer **43** is changed after the transfer is completed and before the reflow process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **43** when the fixing layer **43** accepts each of the devices **20** at the time of the transfer process is slightly different from that when the reflow process is performed. More specifically, when the reflow process is carried out, the degree of the viscosity of the fixing layer **43** may be preferably higher than that at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method. It is to be noted that this step is intended to prevent each of the transferred devices **20** from shifting during a period of time before the reflow process is performed or during the reflow process. Therefore, this step may be omitted when there is no such a possibility.

Subsequently, a reflow process is carried out for the wiring substrate **10** (step S**206**, FIG. **16**). At this time, the solder bump **23** is melted or softened, and thus the metallic layer **22** and the metallic layer **13** are opposed to each other or are exactly face to face with each other due to a self-alignment function of the solder bump **23**. Further, an electrical connection between the transferred device **20** (or the metallic layer **22**) and the wiring substrate **10** (or the metallic layer **13**) is made as a consequence of melting or softening of the solder bump **23**. In other words, the transferred device **20** (or the metallic layer **22**) and the wiring substrate **10** (or the metallic layer **13**) are electrically connected with each other via the electrically-conductive protrusion (the solder bump **23**). After the reflow process, the solder bump **23** is solidified, and accordingly, each of the devices **20** is fixed with high accuracy at a predetermined position on the support substrate **11**.

Finally, the fixing layer **43** is removed (cleaned) (step S**207**). Here, it is sufficient that the flux used as the fixing layer **43** is dissolved, and any residual material is eliminated. A cleaning agent suitable for the flux may be used. At this time, it is possible to remove any material (dirt) attached on the mounting surface of the wiring substrate **10**, such as a residue that may be generated from the laser ablation, in conjunction with the cleaning of the flux. It is to be noted that when the flux is a non-cleaning type, removal of the fixing layer **43** may be omitted.

Next, description is provided on the effects of the method of manufacturing the mounting substrate **1** in this modification example.

In this modification example, the electrical connection between the transferred device **20** and the wiring substrate **10** is made by performing a reflow on the wiring substrate **10** in a state where the transferred device **20** is temporarily fixed to the wiring substrate **10** with the use of the fixing layer **43**. This makes it possible to omit a step of burying a

vacant space between the devices **20** to flatten a surface on which the wiring layer is formed, or a step of forming the wiring layer, in order to make the electrical connection between the device **20** and the wiring. As a result, it is possible to simplify steps following on the transfer process.

Further, as shown in FIG. **13**, when a non-contact transfer (proximity transfer) is carried out, the non-transferred device does not come in contact with the fixing layer **43**. Therefore, a part of the fixing layer **43** or a residue that may be generated from the laser ablation is not attached to the non-transferred device. Consequently, there may be no possibility of deterioration in the transfer performance of the non-transferred device. In addition, in the proximity transfer, there is no necessity for moving the device substrate **30** up and down before or after the transfer process, which allows the transfer processing time to be shortened. Moreover, in the proximity transfer, the device substrate **30** and the wiring substrate **10** do not come in contact with each other. As a result, when there is slight unevenness on the surface (mounting surface) of the wiring substrate **10**, or there is slight waviness on the device substrate **30**, the wiring substrate **10** and/or the like, it is possible to avoid damage to each of the devices **20** that could be caused by a contact transfer.

In addition, as shown in FIG. **16**, when the reflow is carried out, it is possible to improve the alignment accuracy due to the self-alignment function of a solder. Therefore, there may be no necessity for preparing a high-level adjusting apparatus for improving the alignment accuracy during the transfer process. As a result, it is possible to simplify steps during the transfer process, as well as to perform the transfer using inexpensive manufacturing facility. Further, when the electrical connection between the device **20** and the wiring substrate **10** is made using the reflow process, even if a defect in the device **20** is found later, it is possible to take out the defective device **20** with ease. In an existing method in which the device **20** is embedded to form the wiring layer, it is difficult to take out the defective device **20** with ease.

Modification Example 2

Next, description is provided on another modification example of the mounting substrate **1** according to the above-described embodiment and modification example thereof. In the above-described embodiment and modification example thereof, as shown in an example in FIG. **17**A, the metallic layer **22** is provided on the undersurface of the function section **21**, and the whole side surfaces or a part thereof of the metallic layer **22** and the undersurface of the metallic layer **22** are exposed to the outside without being covered by the function section **21**. However, for example, as shown in FIG. **17**B, the metallic layer **22** may be arranged in such a manner that the undersurface of the metallic layer **22** is in the same or almost the same plane as the undersurface of the function section **21**. Alternatively, for example, as shown in FIG. **17**C, the metallic layer **22** may be arranged in such a manner that the undersurface of the metallic layer **22** is located at a position recessed from the undersurface of the function section **21**. It is to be noted that, in FIG. **17**C, a depression is formed on the undersurface of the function section **21** in correspondence with the metallic layer **22**, and the undersurface of the metallic layer **22** is exposed at the bottom of the depression.

Further, in the above-described embodiment and modification example thereof, as shown in an example in FIG. **18**A, the metallic layer **13** is arranged in such a manner that the top surface of the metallic layer **13** is in the same or almost the same plane as the mounting surface of the wiring substrate **10** (the top surface of the insulating layer **12**). However, for example, as shown in FIG. **18**B, the metallic layer **13** may be arranged in such a manner that the top surface of the metallic layer **13** is located at a position recessed from the mounting surface of the wiring substrate **10** (the top surface of the insulating layer **12**). It is to be noted that, in FIG. **18**B, a depression is formed on the mounting surface of the wiring substrate **10** (the top surface of the insulating layer **12**) in correspondence with the metallic layer **13**, and the top surface of the metallic layer **13** is exposed at the bottom of the depression. Alternatively, for example, as shown in FIG. **18**C, the metallic layer **13** may be provided on the mounting surface of the wiring substrate **10** (the top surface of the insulating layer **12**), and the whole side surfaces or a part thereof of the metallic layer **13** and the top surface of the metallic layer **13** may be exposed to the outside without being covered by the insulating layer **12**. At this time, the metallic layer **13** becomes an electrically-conductive protrusion standing out from a surrounding area on the mounting surface of the wiring substrate **10** (the top surface of the insulating layer **12**).

Moreover, in this modification example, the viscosity of the fixing layer **43** is changed after the fixing layer **43** is applied on the top surface of the device substrate **30** and before the transfer process is performed. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **20** after the transfer. Further, in this embodiment of the present application, the degree of the viscosity of the fixing layer **43** is changed after the transfer process is performed and before the reflow process is performed. Also, this makes it possible to reduce the possibility that a positional shift will occur in each of the devices **20** immediately before or in the middle of the reflow process.

3. Second Embodiment

Configuration

Next, description is provided on a mounting substrate **2** according to a second embodiment of the present application. FIG. **19** shows an example of a cross-sectional configuration of the mounting substrate **2**. FIG. **20** shows an example of a top surface configuration of the mounting substrate **2**. FIG. **19** corresponds to a cross-sectional configuration in the direction shown with an arrow A-A in FIG. **20**. The mounting substrate **2** is a substrate where a plurality of devices **60** are mounted on a wiring substrate **50**. The wiring substrate **50** and each of the devices **60** are electrically connected with each other.

The wiring substrate **50** may include, for example, a support substrate **11**, an insulating layer **12**, a metallic layer **13**, and a solder bump **51**. The wiring substrate **50** is equivalent to a substrate in which the solder bump **51** is provided on the wiring substrate **10** in the above-described first embodiment of the present application. The solder bump **51** may be configured of, for example, alloy containing lead or tin as a primary component, and may be formed in a manner of, for example, electrolytic plating, imprinting of a solder paste, and/or the like. It is to be noted that it is not necessary that the solder bump **51** be in a spherical shape from the beginning. The solder bump **51** may take a shape, such as cylinder, circular cone, inverted circular cone, mushroom form, quadrangular pyramid, quadrangular prism, prismatic column, pyramid, polygonal pyramid, and polygonal

column. The solder bump **51** is transformed into an almost spherical shape by surface tension of a solder in a state of being in the form of a liquid with a temperature above the solder melting point. The solder bump **51** is projecting toward the device **60** side on the mounting surface of the wiring substrate **50** (the top surface of the insulating layer **12**), and configures a protrusion standing out from a surrounding area. For example, as shown in FIG. **19**, such an electrically-conductive protrusion may be configured of a block-like (or spherical) metal member. It is to be noted that the electrically-conductive protrusion may be alternatively configured of, for example, a wedge-like metal member.

It is to be noted that FIG. **19** illustrates by an example a case where the wiring substrate **50** has two electrically-conductive protrusions in correspondence with each of the devices **60**. However, the wiring substrate **50** may have one or three or more electrically-conductive protrusions alternatively. The electrically-conductive protrusion may be, for example, in a shape of a rectangle, square, circle, or ellipse when viewed from a direction of a normal to the mounting surface of the wiring substrate **50** (the top surface of the insulating layer **12**). The number of the electrically-conductive protrusion may be preferably three or more in consideration of the stability of the device **60**. When the number of the electrically-conductive protrusion is one or two, the electrically-conductive protrusion may be preferably in a shape of a rectangle or ellipse in consideration of the stability of the device **60**.

As detailed hereinafter, each of the devices **60** on the wiring substrate **50** is transferred on the wiring substrate **50** from a device substrate **70** using a transfer technique. The respective devices **60** are arranged to be away from one another in a plane. The device **60** may be, for example, a submillimeter-sized chip. It is to be noted that the device **60** may be larger in size than a submillimeter size. The device **60** is an individual component to be used as a constituent part for an apparatus or an electronic circuit in a chip-shaped form. Examples of the device **60** may include a light-emitting device (such as an LED, an LD, and an organic EL), a light receiving device (such as a PD), and a circuit device (such as a capacitor, a transistor, a resistor, an IC, and an LSI). Alternatively, the device **60** may be a device that includes at least two out of the above-described light-emitting devices, light receiving devices, and circuit devices, for example.

For example, as shown in FIG. **19**, the device **60** may include a function section **21**, and a metallic layer **22** that is provided on the undersurface of the function section **21**. In other words, the device **60** is equivalent to a device in which the solder bump **23** is removed in the device **20** in the above-described first embodiment.

[Manufacturing Method]

Next, description is provided on an example of a method of manufacturing the mounting substrate **2**.

FIG. **21** shows an example of a manufacturing process for the mounting substrate **2** using a flowchart. Each of FIG. **22** to FIG. **28** shows an example of a manufacturing process for the mounting substrate **2** using a cross-sectional view. First, the device substrate **70** and the wiring substrate **50** are prepared (step S**301**, FIG. **22** and FIG. **23**).

For example, as shown in FIG. **22**, the device substrate **70** may include a support substrate **31**, a fixing layer **32**, and the plurality of devices **60**. The device **60** is equivalent to a device in which the solder bump **23** is removed in the device **20** in the above-described first embodiment. Therefore, the device substrate **70** is equivalent to a substrate in which the solder bump **23** is removed in the device substrate **30** in the above-described first embodiment.

Next, a fixing layer **44** is formed on the undersurface of each of the devices **60** (step S**302**, FIG. **24**). In concrete terms, the fixing layer **44** is formed on a top end of the electrically-conductive protrusion that is configured of the metallic layer **22**. It is to be noted that the fixing layer **44** may be formed only on the undersurface of the device **60** to be transferred among the plurality of devices **60** on the device substrate **70**. The fixing layer **44** accepts each of the devices **60** at the time of the transfer process, while holding one or more of the transferred devices **60** using an adhesive force. More specifically, the fixing layer **44** is a flux. The flux is the same as the flux of the fixing layer **43** that is used in the modification example of the above-described first embodiment.

For example, by the use of a method such as a dip method, a spray method, and printing, the flux is applied with a small and uniform thickness on the top end of the electrically-conductive protrusion. Therefore, at this time, the flux has a low degree of viscosity suitable for coating.

Subsequently, the degree of viscosity of the fixing layer **44** on the device substrate **70** is changed (step S**303**). For example, using at least one method of heating, decompression, light irradiation, and addition of curing agent, a process is carried out that raises the degree of viscosity of the flux applied on the top surface of the device substrate **70**. The degree of the viscosity of the fixing layer **44** is changed after the fixing layer **44** is formed on the device substrate **70** and before the transfer process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **44** when the fixing layer **44** is applied on the device substrate **70** is different from that when the fixing layer **44** accepts each of the devices **60** at the time of the transfer process. More specifically, when the fixing layer **44** is formed on the device substrate **70**, the degree of the viscosity of the fixing layer **44** may be preferably relatively low, and may be preferably relatively high at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method. It is to be noted that, in an embodiment where the optimum degree of viscosity desired for the fixing layer **44** when the fixing layer **44** is applied on the device substrate **70** is not significantly different from that when the fixing layer **44** accepts each of the devices **60** at the time of the transfer process, when the fixing layer **44** is applied on the device substrate **70**, this step may be omitted.

Thereafter, part or all of the plurality of devices **60** on the device substrate **70** are transferred on the wiring substrate **50** (step S**304**). First, the device substrate **70** and the wiring substrate **50** are attached to a transfer apparatus. Next, the device substrate **70** and the wiring substrate **50** are arranged in opposition to each other with a predetermined vacant space **53** interposed between (that is, with them placed away from each other) (FIG. **25**) or with them closely-attached to each other (FIG. **26**). This temporarily fixes the transferred devices **60** on the wiring substrate **50** with the use of the fixing layer **44**. At this time, the fixing layer **44** that is provided on the device **60** to be not transferred may not be preferably in contact with the mounting surface of the wiring substrate **50** (the top surface of the insulating layer **12**). It is to be noted that, when the fixing layer **44** is formed only on the undersurface of the device **60** to be transferred among the plurality of devices **60** on the device substrate **70**, only the fixing layer **44** that is provided on the device **60** to be transferred comes in contact with the mounting surface of the wiring substrate **50** (the top surface of the insulating

layer **12**). Subsequently, one or more of the plurality of devices **60** on the device substrate **70** are transferred on the wiring substrate **50** using, for example, a laser ablation method (FIG. **27**). It is to be noted that such a transfer process may be carried out in a method other than the laser ablation.

After the transfer process, the whole metallic layer **22** or a part thereof and the metallic layer **13** are opposed to each other with the solder bump **23** in between. Further, when viewed from a direction of a normal to the mounting surface of the wiring substrate **50**, it is enough that a portion where the metallic layer **22** and the metallic layer **13** are opposed to each other has an area at least about a half as large as the area of the metallic layer **22**. Therefore, it is enough that this transfer process has the accuracy that allows such a transfer to be achieved.

Afterward, the degree of the viscosity of the fixing layer **44** on the wiring substrate **50** is changed (step S**305**). For example, by heating (post-baking), a process is carried out that raises the degree of viscosity of the flux on the wiring substrate **50**. The degree of the viscosity of the fixing layer **44** is changed after the transfer is completed and before the reflow process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **44** when the fixing layer **44** accepts each of the devices **60** at the time of the transfer process is slightly different from that when the reflow process is performed. More specifically, when the reflow process is carried out, the degree of the viscosity of the fixing layer **44** may be preferably higher than that at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method. It is to be noted that this step is intended to prevent each of the transferred devices **60** from shifting during a period of time before the reflow process is performed or during the reflow process. Therefore, this step may be omitted when there is no such a possibility.

Subsequently, a reflow process is carried out for the wiring substrate **50** (step S**306**, FIG. **28**). At this time, the solder bump **23** is melted or softened, and thus the metallic layer **22** and the metallic layer **13** are opposed to each other or are exactly face to face with each other due to a self-alignment function of the solder bump **23**. Further, an electrical connection between the transferred device **60** (or the metallic layer **22**) and the wiring substrate **50** (or the metallic layer **13**) is made as a consequence of melting or softening of the solder bump **23**. In other words, the transferred device **60** (or the metallic layer **22**) and the wiring substrate **50** (or the metallic layer **13**) are electrically connected with each other via the electrically-conductive protrusion (the solder bump **23**). After the reflow process, the solder bump **23** is solidified, and accordingly, each of the devices **60** is fixed with high accuracy at a predetermined position on the support substrate **11**.

Finally, the fixing layer **44** is removed (cleaned) (step S**307**). Here, it is sufficient that the flux used as the fixing layer **44** is dissolved, and any residual material is eliminated. A cleaning agent suitable for the flux may be used. At this time, it is possible to remove any material (dirt) attached on the mounting surface of the wiring substrate **50**, such as a residue that may be generated from the laser ablation, in conjunction with the cleaning of the flux. It is to be noted that, when the flux is a non-cleaning type, removal of the fixing layer **44** may be omitted.

Next, description is provided on the effects of the method of manufacturing the mounting substrate **2**.

In this embodiment of the present application, the electrical connection between the transferred device **60** and the wiring substrate **50** is made by performing a reflow process on the wiring substrate **50** in a state where the transferred device **60** is temporarily fixed to the wiring substrate **50** with the use of the fixing layer **44**. This makes it possible to omit a step of burying a vacant space between the devices **60** to flatten a surface on which the wiring layer is formed, or a step of forming the wiring layer, in order to make the electrical connection between the device **60** and the wiring. As a result, it is possible to simplify steps following on the transfer process.

Further, as shown in FIG. **25**, when a non-contact transfer (proximity transfer) is carried out, the non-transferred device does not come in contact with the fixing layer **44**. Therefore, a part of the fixing layer **44** or a residue that may be generated from the laser ablation is not attached to the non-transferred device. Consequently, there may be no possibility of deterioration in the transfer performance of the non-transferred device. In addition, in the proximity transfer, there may be no necessity for moving the device substrate **70** up and down before or after the transfer process, which allows the transfer processing time to be shortened. Moreover, in the proximity transfer, the device substrate **70** and the wiring substrate **50** do not come in contact with each other. As a result, when there is slight unevenness on the surface (mounting surface) of the wiring substrate **50**, or there is slight waviness on the device substrate **70**, the wiring substrate **50**, and/or the like, it is possible to avoid damage to each of the devices **60** that could be caused by a contact transfer.

In addition, as shown in FIG. **28**, when the reflow process is carried out, it is possible to improve the alignment accuracy due to the self-alignment function of a solder. Therefore, there may be no necessity for preparing a high-level adjusting apparatus for improving the alignment accuracy during the transfer process. As a result, this makes it possible to simplify steps during the transfer process, as well as to perform the transfer using inexpensive manufacturing facility. Further, when the electrical connection between the device **60** and the wiring substrate **50** is made using the reflow process, even if a defect in the device **60** is found later, it is possible to take out the defective device **60** with ease. In an existing method of embedding the device **60**, it is difficult to take out the defective device **60** with ease.

Moreover, in this embodiment of the present application, the degree of the viscosity of the fixing layer **44** is changed after the fixing layer **44** is applied on the top surface of the device substrate **70** and before the transfer process is performed. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **60** after the transfer. Further, in this embodiment of the present application, the degree of the viscosity of the fixing layer **44** is changed after the transfer process is performed and before the reflow process is performed. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **60** immediately before or in the middle of the reflow process.

4. Modification Examples of Second Embodiment

Modification Example 1

Next, description is provided on a modification example of a method of manufacturing the mounting substrate **2** according to the above-described second embodiment of the present application. FIG. **29** shows another example of a

manufacturing process for the mounting substrate **2** using a flowchart. Each of FIG. **30** to FIG. **34** shows another example of a manufacturing process for the mounting substrate **2** using a cross-sectional view. In this modification example, a fixing layer **45** is used instead of the fixing layer **44**. This fixing layer **45** is applied on the wiring substrate **50**.

First, the device substrate **70** and the wiring substrate **50** are prepared (step S**401**, FIG. **22** and FIG. **23**). Next, the fixing layer **45** is formed over a whole area of the top surface of the wiring substrate **50** (step S**402**, FIG. **30**). It is to be noted that the fixing layer **45** may be alternatively formed only on the top surface of the solder bump **51** or only over a whole surface of the solder bump **51**. The fixing layer **45** accepts each of the devices **60** at the time of the transfer process, while holding one or more of the transferred devices **60** using an adhesive force. More specifically, the fixing layer **45** is a flux. The flux is the same as the flux of the fixing layer **41** that is used in the above-described first embodiment of the present application.

For example, by the use of a method such as spin coating, a spray method, a doctor blade method, printing, a transfer method, and an imprinting method, the flux is applied with a small and uniform thickness over a whole area of the top surface of the wiring substrate **50**. Therefore, at this time, the flux has a low degree of viscosity suitable for coating.

Subsequently, the degree of the viscosity of the fixing layer **45** on the wiring substrate **50** is changed (step S**403**). For example, using at least one method of heating, decompression, light irradiation, and addition of curing agent, a process is carried out that raises the degree of viscosity of the flux applied on the device substrate **70**. The degree of the viscosity of the fixing layer **45** is changed after the fixing layer **45** is formed on the wiring substrate **50** and before the transfer process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **45** when the fixing layer **45** is applied on the top surface of the wiring substrate **50** is different from that when the fixing layer **45** accepts each of the devices **60** at the time of the transfer process. More specifically, when the fixing layer **45** is formed on the wiring substrate **50**, the degree of the viscosity of the fixing layer **45** may be preferably relatively low, and may be preferably relatively high at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method.

Thereafter, part or all of the plurality of devices **60** on the device substrate **70** are transferred on the wiring substrate **50** (step S**404**). First, the device substrate **70** and the wiring substrate **50** are attached to a transfer apparatus. Next, the device substrate **70** and the wiring substrate **50** are arranged in opposition to each other with a predetermined vacant space **53** interposed between (that is, with them placed away from each other) (FIG. **31**) or with them closely-attached to each other (FIG. **32**). Subsequently, one or more of the plurality of devices **60** on the device substrate **70** are transferred on the wiring substrate **50** using, for example, a laser ablation method (FIG. **33**). This temporarily fixes the transferred device(s) **60** on the wiring substrate **50** with the use of the fixing layer **45**. It is to be noted that such a transfer process may be carried out in a method other than the laser ablation.

After the transfer process, the whole metallic layer **22** or a part thereof and the metallic layer **13** are opposed to each other with the solder bump **23** in between. Further, when viewed from a direction of a normal to the mounting surface of the wiring substrate **50**, it is enough that a portion where the metallic layer **22** and the metallic layer **13** are opposed to each other has an area at least about a half as large as the area of the metallic layer **22**. Therefore, it is enough that this transfer process has the accuracy that allows such a transfer to be achieved.

Afterward, the degree of the viscosity of the fixing layer **45** on the wiring substrate **50** is changed (step S**405**). For example, by heating (post-baking), a process is carried out that raises the degree of viscosity of the flux coated on the wiring substrate **50**. The degree of the viscosity of the fixing layer **45** is changed after the transfer is completed and before the reflow process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **45** when the fixing layer **45** accepts each of the devices **60** at the time of the transfer process is slightly different from that when the reflow process is performed. More specifically, when the reflow process is carried out, the degree of the viscosity of the fixing layer **45** may be preferably higher than that at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method. It is to be noted that this step is intended to prevent each of the transferred devices **60** from shifting during a period of time before the reflow process is performed or during the reflow process. Therefore, this step may be omitted when there is no such a possibility.

Subsequently, a reflow process is carried out for the wiring substrate **50** (step S**406**, FIG. **34**). At this time, the solder bump **23** is melted or softened, and thus the metallic layer **22** and the metallic layer **13** are opposed to each other or are exactly face to face with each other due to a self-alignment function of the solder bump **23**. Further, an electrical connection between the transferred device **60** (or the metallic layer **22**) and the wiring substrate **50** (or the metallic layer **13**) is made as a consequence of melting or softening of the solder bump **23**. In other words, the transferred device **60** (or the metallic layer **22**) and the wiring substrate **50** (or the metallic layer **13**) are electrically connected with each other via the electrically-conductive protrusion (the solder bump **23**). After the reflow process, the solder bump **23** is solidified, and accordingly, each of the devices **60** is fixed with high accuracy at a predetermined position on the support substrate **11**.

Finally, the fixing layer **45** is removed (cleaned) (step S**407**). Here, it is sufficient that the flux used as the fixing layer **45** is dissolved, and any residual material is eliminated. A cleaning agent suitable for the flux may be used. At this time, it is possible to remove any material (dirt) attached on the mounting surface of the wiring substrate **50**, such as a residue that may be generated from the laser ablation, in conjunction with the cleaning of the flux. It is to be noted that, when the flux is a non-cleaning type, removal of the fixing layer **45** may be omitted.

Next, description is provided on the effects of the method of manufacturing the mounting substrate **2** according to this modification example.

In this modification example, the electrical connection between the transferred device **60** and the wiring substrate **50** is made by performing a reflow process for the wiring substrate **50** in a state where the transferred device **60** is temporarily fixed to the wiring substrate **50** with the use of the fixing layer **45**. This makes it possible to omit a step of burying a vacant space between the devices **60** to flatten a surface on which the wiring layer is formed, or a step of forming the wiring layer, in order to make the electrical connection between the device **60** and the wiring. As a result, it is possible to simplify steps following on the transfer process.

Further, as shown in FIG. **31**, when a non-contact transfer (proximity transfer) is carried out, the non-transferred device does not come in contact with the fixing layer **45**. Therefore, a part of the fixing layer **45** or a residue that may be generated from the laser ablation is not attached to the non-transferred device. Consequently, there may be no possibility of deterioration in the transfer performance of the non-transferred device. In addition, in the proximity transfer, there may be no necessity for moving the device substrate **70** up and down before or after the transfer process, which allows the transfer processing time to be shortened. Moreover, in the proximity transfer, the device substrate **70** and the wiring substrate **50** do not come in contact with each other. As a result, when there is slight unevenness on the surface (the mounting surface) of the wiring substrate **50**, or there is slight waviness on the device substrate **70**, the wiring substrate **50**, and/or the like, it is possible to avoid damage to each of the devices **60** that could be caused by a contact transfer.

In addition, as shown in FIG. **34**, when the reflow process is carried out, it is possible to improve the alignment accuracy due to the self-alignment function of a solder. Therefore, there may be no necessity for preparing a high-level adjusting apparatus for improving the alignment accuracy during the transfer process. As a result, it is possible to simplify steps during the transfer process, as well as to perform the transfer using inexpensive manufacturing facility. Further, when the electrical connection between the device **60** and the wiring substrate **50** is made using the reflow process, even if a defect in the device **60** is found later, it is possible to take out the defective device **60** with ease. In an existing method of embedding the device **60**, it is difficult to take out the defective device **60** with ease.

Moreover, in this modification example, the degree of the viscosity of the fixing layer **45** is changed after the fixing layer **45** is applied on the top surface of the wiring substrate **50** and before the transfer process is performed. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **60** after the transfer. Further, in this modification example, the degree of the viscosity of the fixing layer **45** is changed after the transfer process is performed and before the reflow process is performed. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **60** immediately before or in the middle of the reflow process.

Modification Example 2

Next, description is provided on another modification example of the mounting substrate **2** according to the above-described second embodiment and modification example thereof. In the above-described second embodiment and modification example thereof, for example, as shown in FIG. **35**A, the metallic layer **22** is provided on the undersurface of the function section **21**, and the whole side surfaces or a part thereof of the metallic layer **22** and the undersurface of the metallic layer **22** are exposed to the outside without being covered by the function section **21**. However, for example, as shown in FIG. **35**B, the metallic layer **22** may be arranged in such a manner that the undersurface of the metallic layer **22** is in the same or almost the same plane as the undersurface of the function section **21**. Further, for example, as shown in FIG. **35**C, the metallic layer **22** may be arranged in such a manner that the undersurface of the metallic layer **22** is located at a position recessed from the undersurface of the function section **21**. It is to be noted that, in FIG. **35**C, a depression is formed on the undersurface of the function section **21** in correspondence with the metallic layer **22**, and the undersurface of the metallic layer **22** is exposed at the bottom of the depression.

Further, in the above-described embodiment and modification example thereof, as shown in an example in FIG. **36**A, the metallic layer **13** is arranged in such a manner that the top surface of the metallic layer **13** is in the same or almost the same plane as the mounting surface of the wiring substrate **50** (the top surface of the insulating layer **12**). However, for example, as shown in FIG. **36**B, the metallic layer **13** may be arranged in such a manner that the top surface of the metallic layer **13** is located at a position recessed from the mounting surface of the wiring substrate **50** (the top surface of the insulating layer **12**). It is to be noted that, in FIG. **36**B, a depression is formed on the mounting surface of the wiring substrate **50** (the top surface of the insulating layer **12**) in correspondence with the metallic layer **13**, and the top surface of the metallic layer **13** is exposed at the bottom of the depression. Alternatively, for example, as shown in FIG. **36**C, the metallic layer **13** may be provided on the mounting surface of the wiring substrate **50** (the top surface of the insulating layer **12**), and the whole side surface or a part thereof of the metallic layer **13** and the top surfaces of the metallic layer **13** may be exposed to the outside without being covered by the insulating layer **12**.

5. Third Embodiment

Configuration

Next, the description is provided on a mounting substrate **3** according to a third embodiment of the present application. FIG. **37** shows an example of a cross-sectional configuration of the mounting substrate **3**. The mounting substrate **3** is a substrate where a plurality of devices **60** are mounted on a support substrate **80** with a fixing layer **81** in between. The support substrate **80** and each of the devices **60** are electrically separated from each other by the fixing layer **81**.

For example, as shown in FIG. **37**, the mounting substrate **3** may include the support substrate **80**, the fixing layer **81**, an insulating layer **82**, the plurality of devices **60**, a plurality of wires **83**, and a plurality of wires **84**. The support substrate **80** supports the plurality of devices **60**, and may be configured of, for example, a silicon substrate, a glass substrate, a resin substrate, or the like. In the support substrate **80**, the surface on the device **60** side is a flat surface. That is, the mounting surface of the support substrate **80** is a flat surface. The fixing layer **81** fixes each of the devices **60** on the support substrate **80**. It is to be noted that the fixing layer **81** also accepts each of the devices **60** at the time of the transfer process, and holds one or more of the transferred devices **60** using an adhesive force. The fixing layer **81** may be configured of, for example either an adhesive material or a sticking material. The insulating layer **82** is a layer for burying each of the devices **60** therein and for forming a flat surface on the top surface of the mounting substrate **3**, and serves as an interlayer insulating film as well. The insulating layer **82** may be configured of, for example, an insulating material such as polyimide. The wires **83** and **84** are configured to make an electrical connection between each of the devices **60** and an external circuit, and are electrically connected with the metallic layer **22** on each of the devices **60**. Each of the devices **60** is arranged on the support substrate **80** with the metallic layer **22** directed upward (that is, with the metallic layer **22** directed toward the opposite side, of the function section **21**,

from the support substrate **80**). Therefore, in each of the devices **60**, the function section **21** is connected with the fixing layer **81**.

[Manufacturing Method]

Next, description is provided on an example of a method of manufacturing the mounting substrate **3**.

FIG. **38** shows an example of a manufacturing process for the mounting substrate **3** using a flowchart. Each of FIG. **39** to FIG. **43** shows an example of a manufacturing process for the mounting substrate **3** using a cross-sectional view. First, a device substrate **100** and the support substrate **80** are prepared (step S**501**, FIG. **39** and FIG. **40**).

For example, as shown in FIG. **39**, the device substrate **100** may include a support substrate **101**, a fixing layer **102**, and the plurality of devices **60**. Each of the devices **60** is arranged on the support substrate **101** with the metallic layer **22** directed downward (that is, with the metallic layer **22** directed toward the support substrate **101** side in relationship with the function section **21**). Therefore, in each of the devices **60**, the metallic layer **22** is in contact with the fixing layer **102**. The support substrate **101** supports the plurality of devices **60**, and may be configured of, for example, a silicon substrate, a glass substrate, a resin substrate, or the like. The fixing layer **102** fixes each of the devices **60** on the support substrate **101**, and peels off each of the devices **60** from the support substrate **101** at the time of the transfer process. When a transfer is carried out in a laser ablation method, the fixing layer **102** may be configured of, for example, a material that absorbs light at laser oscillation wavelength band. The fixing layer **102** may be formed, for example, over a whole area of the top surface of the support substrate **101**. For example, as shown in FIG. **39**, the fixing layer **102** may be formed only at a gap between the support substrate **101** and each of the devices **60**. Considering the transfer characteristics, as shown in FIG. **39**, the fixing layer **102** may be preferably formed for each of the devices **60**. Further, considering the simplicity of the process, the fixing layer **102** may be preferably formed over a whole area of the top surface of the support substrate **101**. The fixing layer **102** may come in direct contact with the support substrate **101**. It is to be noted that an adhesion layer, an insulating layer, a metallic layer, and/or the like may be interposed between the fixing layer **102** and the support substrate **101**.

Next, a fixing layer **81** is formed over a whole area of the top surface of the support substrate **80** (step S**502**, FIG. **41**). The fixing layer **81** accepts each of the devices **60** at the time of the transfer process, while holding one or more of the transferred devices **60** using an adhesive force. More specifically, the fixing layer **81** is either an adhesive material or a sticking material. Subsequently, the degree of the viscosity of the fixing layer **81** on the support substrate **80** is changed (step S**503**). For example, using a heating treatment, a process is carried out that raises the degree of viscosity of an adhesive material or a sticking material that is applied on the top surface of the support substrate **80**. The degree of the viscosity of the fixing layer **81** is changed after the fixing layer **81** is formed on the top surface of the support substrate **80** and before the transfer process to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **81** when the fixing layer **81** is applied on the top surface of the support substrate **80** is different from that when the fixing layer **81** accepts each of the devices **60** at the time of the transfer process. More specifically, when the fixing layer **81** is formed on the top surface of the support substrate **80**, the degree of the viscosity of the fixing layer **81** may be preferably relatively low, and may be preferably relatively high at the time of the transfer process. When heating is used for changing the degree of viscosity, a solvent contained in the adhesive material or the sticking material is volatized by heating the support substrate **80** using, for example, a hot plate, an atmosphere furnace, an infrared heating furnace, and/or the like to change the degree of viscosity of the adhesive material or the sticking material.

Thereafter, part or all of the plurality of devices **60** on the device substrate **100** are transferred on the support substrate **80** (step S**504**). First, the device substrate **100** and the support substrate **80** are attached to a transfer apparatus. Next, the device substrate **100** and the support substrate **80** are arranged in opposition to each other with them closely-attached to each other (FIG. **42**). Subsequently, one or more of the plurality of devices **60** on the device substrate **100** are transferred on the support substrate **80** using, for example, a laser ablation method (FIG. **43**). This temporarily fixes the transferred device(s) **60** on the support substrate **80** with the use of the fixing layer **81**. It is to be noted that such a transfer process may be carried out in a method other than the laser ablation.

Afterward, the degree of the viscosity of the fixing layer **81** on the support substrate **80** is changed (step S**505**). For example, using a heating treatment, a process is carried out that raises the degree of viscosity of the adhesive material or the sticking adhesive material that is applied on the top surface of the support substrate **80**. The degree of the viscosity of the fixing layer **81** is changed after the transfer is completed and before embedding to be hereinafter described is performed. One reason for this is that the optimum degree of viscosity desired for the fixing layer **81** when the fixing layer **81** accepts each of the devices **60** at the time of the transfer process is slightly different from that when the embedding is performed. More specifically, when the embedding is carried out, the degree of the viscosity of the fixing layer **81** may be preferably higher than that at the time of the transfer process. A specific method of changing the degree of viscosity is similar to the above-described method. It is to be noted that this step is intended to prevent each of the transferred devices **60** from shifting during a period of time before the embedding is performed or during the embedding process. Therefore, this step may be omitted when there is no such a possibility. Finally, each of the devices **60** is embedded to form the insulating layer **82**, as well as the wires **83** and **84**.

[Effects]

Next, description is provided on the effects of the method of manufacturing the mounting substrate **3**.

In this embodiment of the present application, the degree of the viscosity of the fixing layer **81** is changed after the fixing layer **81** is coated on the top surface of the support substrate **80** and before the transfer process is performed. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **60** after the transfer. Further, in this embodiment, the degree of the viscosity of the fixing layer **81** is changed after the transfer process is performed and before each of the devices **60** is embedded. This makes it possible to reduce the possibility that a positional shift will occur in each of the devices **60** immediately before or in the middle of the embedding.

6. Fourth Embodiment

Configuration

Next, description is provided on an electronic apparatus **4** according to a fourth embodiment of the present application.

FIG. **44** shows an example of a simplified configuration of the electronic apparatus **4**. The electronic apparatus **4** includes any one of the mounting substrates **1**, **2**, and **3**, and a control section **5** that is electrically connected with the mounting substrate **1**, **2**, or **3**. The control section **5** may be, for example, a circuit that applies a voltage or a current to the mounting substrate **1**, **2**, or **3**, or receives an output from the mounting substrate **1**, **2**, or **3**. In the electronic apparatus **4**, the mounting substrate **1**, **2**, or **3** may serve as, for example, a light-emitting panel, a display panel, or a light-receiving panel due to application of a voltage or a current by the control section **5** to the mounting substrate **1**, **2**, or **3**.

[Manufacturing Method]

Subsequently, description is provided on an example of a method of manufacturing the electronic apparatus **4** including any one of the mounting substrates **1**, **2**, and **3**. First, using any of the methods described in the above-described embodiments and modification examples thereof, the mounting substrate **1**, **2**, or **3** is formed (for example, see FIG. **3**, FIG. **11**, FIG. **21**, FIG. **29**, and FIG. **38**). Next, the control section **5** is prepared, and thereafter, the mounting substrate **1**, **2**, or **3** and the control section **5** are electrically connected with each other. Thus, the electronic apparatus **4** is formed.

[Effects]

Next, description is provided on the effects of the method of manufacturing the electronic apparatus **4**.

In this embodiment of the present application, using any of the methods described in the above-described embodiments and modification examples thereof, any one of the mounting substrates **1**, **2**, and **3** is formed. This makes it possible to use a more inexpensive and easier-to-repair mounting substrate for the electronic apparatus **4** as compared with a mounting substrate that is formed using an existing method.

The present application is described thus far with reference to some embodiments and modification examples thereof. However, the present application is not limited to the above-described embodiments and the like, and various modifications may be made.

For example, in the above-described third embodiment, a chip-shaped material may be transferred instead of the device **60**. More specifically, in the present application, the device may not necessarily have unique function by itself, and may be configured of, for example, a chip-shaped material. On this occasion, in the device, the surface on the support substrate **81** side may be a flat surface. Further, on this occasion, in the support substrate **81**, the mounting surface thereof may be a flat surface. Further, when the device is configured of a chip-shaped material, the device may have one or more protrusions on the surface on the support substrate **81** side. This protrusion has a role (a role as an anchor) that is similar to that of the protrusion in the above-described first embodiment. For example, as shown in FIG. **45**, a chip-shaped material **110** may have a plurality of protrusions **111** on the underside thereof (a surface on the support substrate **81** side). In this case, each of the protrusions **111** has a role as an anchor.

Further, for example, it is possible to achieve at least the following configurations from the above-described example embodiments and the modifications of the present application.

(1) A method of manufacturing a mounting substrate, the method including:

transferring part or all of a plurality of devices on a device substrate onto a wiring substrate, and temporarily fixing the transferred devices to the wiring substrate with use of a fixing layer having viscosity, the device substrate including a support substrate and the plurality of devices fixed on the support substrate; and performing a reflow process on the wiring substrate to electrically connect the transferred devices with the wiring substrate, and thereby forming the mounting substrate.

(2) The method according to (1), wherein

each of the devices has one or more first metallic parts on a surface of the device,

the wiring substrate has one or more second metallic parts on a surface of the wiring substrate,

either or both of the first metallic part and the second metallic part has an electrically-conductive protrusion standing out from a surrounding area, and

the first metallic part is electrically connected with the second metallic part via the protrusion through the performing of the reflow process.

(3) The method according to (2), wherein the protrusion includes one or both of a solder bump and a solder diffusion suppression layer.

(4) The method according to (2) or (3), wherein

the first metallic part has the protrusion, and

the first metallic part includes a solder bump serving as the protrusion.

(5) The method according to (4), wherein

the second metallic part also has the protrusion, and

the second metallic part includes a solder diffusion suppression layer serving as the protrusion.

(6) The method according to (4), wherein the second metallic part has no the protrusion, and is provided at a position that is same or lower in height as compared with the surrounding area.

(7) The method according to any one of (1) to (6), further including removing the fixing layer after the reflow process is performed.

(8) The method according to any one of (1) to (7), further including performing a process of raising a degree of viscosity of the fixing layer before the transferring is performed.

(9) The method according to (8), further including performing a process of raising the degree of the viscosity of the fixing layer after the transferring is performed and before the reflow process is performed.

(10) The method according to (8), further including performing the process of raising the degree of the viscosity of the fixing layer by one or more methods out of heating, decompression, light irradiation, and addition of a curing agent.

(11) A method of manufacturing an electronic apparatus, the method including:

transferring part or all of a plurality of devices on a device substrate onto a wiring substrate, and temporarily fixing the transferred devices to the wiring substrate with use of a fixing layer having viscosity, the device substrate including a support substrate and the plurality of devices fixed on the support substrate;

performing a reflow process on the wiring substrate to electrically connect the transferred devices with the wiring substrate, and thereby forming the mounting substrate; and

electrically connecting the mounting substrate with a control section, and thereby forming an electronic apparatus.

Also, for example, it is possible to achieve at least the following configurations from the above-described example embodiments and the modifications of the present application.

(12) A method of manufacturing a mounting substrate, the method of manufacturing a mounting substrate where a plurality of devices are mounted on a transfer substrate including:

performing a process of raising a degree of viscosity of a fixing layer having viscosity after coating the fixing layer on a surface of the transfer substrate; and

transferring some or all of the plurality of devices on a device substrate where the plurality of devices are fixed on a support substrate on the transfer substrate.

(13) The method according to (12), further including:

performing a process of raising a degree of viscosity of the fixing layer using at least one method of heating, decompression, light irradiation, and addition of curing agent.

(14) The method according to (12) or (13), wherein the fixing layer is any one of a flux, an adhesive material, and a pressure-sensitive adhesive material.

(15) The method according to (12) or (13), wherein the fixing layer is either an adhesive material or a pressure-sensitive adhesive material.

(16) The method according to (12), (13), or (15), wherein

in each of the devices, a surface of the transfer substrate is a flat surface, and

in the transfer substrate, a mounting surface for each of the devices is a flat surface.

(17) The method according to (16), wherein each of the devices has one or more first metallic parts on a surface on the opposite side of a surface on the transfer substrate side.

(18) A method of manufacturing an electronic apparatus, the method of manufacturing an electronic apparatus provided with a mounting substrate where a plurality of devices are mounted on a transfer substrate including:

performing a process of raising a degree of viscosity of a fixing layer having viscosity after coating the fixing layer on a surface of the transfer substrate; and

transferring some or all of the plurality of devices on a device substrate where the plurality of devices are fixed on a support substrate on the transfer substrate.

It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present subject matter and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

The invention is claimed as follows:

1. A method of manufacturing a mounting substrate, the method comprising:

performing, at a first time, a first viscosity modification process of raising a degree of viscosity of a fixing layer on a wiring substrate, the wiring substrate including a first support substrate, an insulating layer, and metallic parts on a first surface of the insulating layer of the wiring substrate;

after the first viscosity modification process, at a second time, transferring part or all of a plurality of devices on a device substrate onto the wiring substrate by a transfer process, and temporarily fixing the transferred devices to the wiring substrate with use of the fixing layer on the wiring substrate, the device substrate including a second support substrate and the plurality of devices fixed on the second support substrate, each of the transferred devices having one or more conductive protrusions on a surface thereof that are partially embedded in the fixing layer but without contacting the metallic parts of the wiring substrate, each conductive protrusion including a metallic layer and a solder bump;

after the transfer process, performing, at a third time, a second viscosity modification process of further raising the degree of viscosity of the fixing layer by one or more methods selected from the group consisting of decompression, light irradiation, and addition of a curing agent, wherein a thickness of the metallic layer, in a direction of a normal to a second surface of the wiring substrate, is less than a thickness of the fixing layer in a same direction, a thickness of the solder bump, in the same direction, is less than the thickness of the fixing layer in the same direction, and a thickness of the one or more conductive protrusions, in the same direction, is greater than the thickness of the fixing layer in the same direction, the second surface being an interface between the first support substrate and a second surface of the insulating layer, and the thickness of the one or more conductive protrusions is a distance in the same direction from a first tip and a second tip opposite the first tip;

after the second viscosity modification process, performing the reflow process on the wiring substrate to reflow and electrically connect the embedded metallic layer of transferred devices with the metallic parts of the wiring substrate, and thereby forming the mounting substrate; and

removing the fixing layer.

2. The method according to claim **1**, further comprising performing the first process of raising the degree of the viscosity of the fixing layer by one or more methods selected from the group consisting of heating, decompression, light irradiation, and addition of a curing agent.

3. The method according to claim **1**, wherein the second viscosity modification process prevents the transferred plurality of devices from shifting during a period of time before the reflow process.

4. A method of manufacturing an electronic apparatus, the method comprising:

performing, at a first time, a first viscosity modification process of raising a degree of viscosity of a fixing layer on a wiring substrate, the wiring substrate including a first support substrate, an insulating layer, and metallic parts on a first surface of the insulating layer of the wiring substrate;

after the first viscosity modification process, at a second time, transferring part or all of a plurality of devices on a device substrate onto the wiring substrate by a transfer process, and temporarily fixing the transferred devices to the wiring substrate with use of the fixing layer on the wiring substrate, the device substrate including a second support substrate and the plurality of devices fixed on the second support substrate, each of the transferred devices having one or more conductive protrusions on a surface thereof that are partially embedded in the fixing layer but without contacting the metallic parts of the wiring substrate, each conductive protrusion including a metallic layer and a solder bump;

after the transfer process, performing, at a third time, a second viscosity modification process of further raising the degree of viscosity of the fixing layer by one or more methods selected from the group consisting of decompression, light irradiation, and addition of a curing agent, wherein a thickness of the metallic layer, in a direction of a normal to a second surface of the

wiring substrate, is less than a thickness of the fixing layer in a same direction, a thickness of the solder bump, in the same direction, is less than the thickness of the fixing layer in the same direction, and a thickness of the one or more conductive protrusions, in the same direction, is greater than the thickness of the fixing layer in the same direction, the second surface being an interface between the first support substrate and a second surface of the insulating layer, and the thickness of the one or more conductive protrusions is a distance in the same direction from a first tip and a second tip opposite the first tip;

after the second viscosity modification process, performing the reflow process on the wiring substrate to reflow and electrically connect the embedded first metallic layer of transferred devices with the metallic parts of the wiring substrate, and thereby forming a mounting substrate;

removing the fixing layer; and

forming the electronic apparatus including the mounting substrate.

5. The method according to claim **4**, wherein the second viscosity modification process prevents the transferred plurality of devices from shifting during a period of time before the reflow process.

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